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I

CONFESSIONS OF A SCHOOL TRUSTEE

Once upon a time I had the honor of serving as a school trustee, a position which I held for nearly ten years. The place was an eastern city of less than one hundred thousand people. As a young man, I had been a schoolteacher, had attained experience in a rural school, had past thru the various grades of high school principal, normal school instructor, and university assistant professor. From that position I graduated to one which kept me in contact with men of commanding position in the business world.

When I had taken my place as a member of the school board I fully expected to be appointed to a committee that would put me in contact with the administration of the schools. Later on, I learned that both the superintendent and the chairman of the committee in question conferred with the president of the board to oppose such an appointment. The president agreed with them. "T'ell with him," the president said; "we've been running things satisfactorily for twenty years, and it hain't no time to change now." I was appointed to a committee that looked after school properties—"back yards and grate-bars," it was facetiously called.

The then chairman of this committee was an Irishman. He was a Democrat in a ward that was overwhelmingly Republican, and a Catholic in a part of the community that was almost wholly Protestant. He had been a trustee for nearly five years before I was elected, and we served to-

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gether for about seven years. He was wealthy and was holding a very responsible position in a great corporation; he was also old gold from toe to crown.

"Ye'll make the rounds wit' me Sathurday; we must be av one moind whin th' budget is made up. Ye wud bether take a look about in th' mane toime."

I took a look in the meantime and made the acquaintance of principals, janitors and teachers; I likewise gathered some useful information. When Saturday came, Branigan —that wasn't his name—steered me thru a thoro inspection of the school properties. There were some pretty bad features. Many of the floors were laid with flat-grained stuff and were not only badly splintered, but the boards were cupped as well. There was loose plastering that was a menace; woodwork that had weathered and warped for want of paint; toilets that were a disgrace for want of intelligent care; playgrounds whose surface had never been made dustproof; ventilating ducts that were belching soot and ashes instead of clean air; and sheet-metal work thru which great holes had rusted for want of paint.

"Do yez think well of it?" Branigan asked, when we had finished the tour of inspection. A twinkle in his eye answered the question.

"Rotten," I replied, and emphasized my opinion by kicking a half-rotted toilet door off its surviving hinge.

Branigan went on to tell me that the repairs to the school properties were flimsy in character and so insufficient that they nowhere offset ordinary deterioration. As a result, a much larger sum was required when the building became so badly out of order as to be practically untenable. As a matter of fact, in a period of ten years, three buildings had been closed by the city health board, and work on one had been stopt by the building inspector because of the poor quality of the material employed. During his first term, Branigan said that he had urged a more business-like system of care for the buildings, but it had required six of the eight trustees to carry a resolution for spending money on repairs. With my election the six votes were

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on hand. He said that we would better lose no time in working out a plan of repairs which would put every building in a good condition. In his opinion that was the only real economy. Being the junior member of the committee, Branigan kindly permitted me to undertake the job, and I agreed to have the figures ready at an early date. That was twelve years ago, and a strict regard for the facts of the case compels me to admit that I was several years in obtaining the information. The repair of one defect so frequently uncovered others that it seemed as tho we should never reach the end.

There were many things, however, that I got by heart. For instance: A metal roof, painted as often as required and otherwise kept in order should last twenty-five years; but the painting should be done when needed, and not at stated intervals; outside woodwork should also be painted when necessary, without referring to time intervals; a well-laid floor of comb-grained pine will outlast one of flat grain five or six to one; gutters and leaders of copper on the south side of a building will outlast those of galvanized iron many times over; and that no amount of painting will prevent the bursting of iron leaders when the water filling them freezes.

In short, I learned that the flimsy sort of repairs that we were putting on our school properties were far more expensive than good, thoro work would have been. Once, when I exploded about a contract of window painting and puttying given to the lowest bidder at a figure for which honest work could not possibly be done, Branigan soothingly remarked: "Ye be larnin' a bit; Oi thocht ye wud." Several responsible bidders had competed for this job, and the work of any one of them would have been acceptable. Previously, the same job had been given to a crooked workman and had lasted less than two years. As I figured it, the material used had been of the poorest kind and had been covered with paint that had disappeared during the first winter. The fact which aroused my ire was that the lowest bidder was the same man that had done the work before.

"You must have known that he couldn't have done a decent job at the price," I said to Branigan.

"Av coorse Oi knew," said Branigan; "but whin Oi remairked that the man was a chape, lyin' skate, he bein' prisint, th' president he remarked that 'rules is rules,' an' that Oi must ixicute th' contract, which Oi did." And that was the way things were going.

When the contracts for the summer repairs were awarded, Branigan informed me that I would have charge of the painting. He asked me if I knew anything about the work, and I was obliged to confess that my knowledge extended only to certain lurid colors somewhat freely used in youthful days. "Thin ye'll see th' Smith byes furrst," he said.

The Smith Brothers were one of the three or four leading master painters in the city. They were not bidders on any of the jobs and I was curious to know why. To my question, the office manager informed me that they could not possibly do good work at the rates we were paying, and that they did not wish to lower the quality of their work. They were heavy taxpayers, however, and for that reason were anxious that all work on public buildings should be good and substantial. The advice and information I had from them was good and to the point. I was to see that the white lead which came to the job was in original packages; that the paint was mixt where the job was done, and that none of the material was spirited away and replaced with inferior stuff. This trick was tried only once in my time. Branigan allowed the contractor to finish the job and then required him to put on an additional coat of good paint at his own expense.

One discovery which I made was disconcerting. The plastered walls in a number of classrooms were included in one of the painting contracts. The regulations governing such contracts were plain: "two coats—that shall evenly cover, without streaks or flashes, and conceal all cracks and feather-veins." The contractor on this job was painting the cracks, but he was not shellacking them, a process which the Smith Brothers said was necessary. To my criticism,

the contractor said that shellacking was not included in the contract, and that he would see me in a place whose name is eliminated from polite society before he would incur an expense not nominated.

Now, this man had always been straightforward in his dealings with me and we had employed him at various times. He said frankly that the job was not a good one, but that he was complying to the letter with the terms of the contract. He said that it was impossible to make two coats cover without an adulterant and that the specifications did not forbid the use of such a substance. He added that, collectively, the school board was a lot of man-eating sharks and that he would beat us every time he had the opportunity—"and you can't help yourselves when I am the lowest bidder; them's the rules."

I might have got mad and said naughty words; instead, I sat down and began to ask questions. "Then you wouldn't call this a strictly first job?" I asked.

"Hell, no; but it's up to the contract."

"How long will it last?"

"Well, it'll begin to 'alligator' in a couple of years, 'n' in another year it'll peel pretty considerable."

"How long will an honest painting last?"

"Eight or ten years, barring cracks; and you can wash it as often as you like if you use a mild soap."

"And how many coats will be needed?"

"Three coats on old walls; four on new plaster."

In the conversation I discovered that the contractor had a grouch and a grievance against the school board and that he was playing to get even. He remarked with emphasis that he had us skinned, and that we could not help ourselves; he also boasted that if he could make the work any poorer and get away with it he would do so. And that was the attitude of many of our contractors.

I conferred with Branigan and then got the contractor to estimate on a third coat of his best work at our expense. At the board meeting on the next evening Branigan put the matter before the board on its merits. The president went

up in the air: "Rules are rules," he said, "and the trustee from the tenth ward ought to know that the resolution will invalidate the contract." To make a long story short, in spite of the war whoops of the president, we made a new contract and the result was a good, honest job that has stood to this day.

I mention this case in detail to emphasize the fact that, in driving sharp bargains with contractors, the board almost always overreached itself and came out second best. The old saw "if you want a square deal give one," was not one of the rules which the president had learned. I recall an instance when the two lowest bidders on a contract were whipsawed against each other until a cut of several thousand dollars below the lowest bid was effected. The work finally went to an irresponsible bidder. It was a fine piece of business stupidity; and before we were thru with it, we paid for a second-rate job about five thousand dollars more than the highest bid submitted.

It was the boast of the president that the repairs on our school properties never exceeded more than five thousand dollars in any one year. This was not true; as a matter of fact the expenditures, honestly computed, were far in excess of this sum. The repairs were so inadequate that they did not make deterioration good. When a building had deteriorated until it was untenable, it was "rebuilt" by funds raised by a bond issue, and the amount was charged against building expenses. In this manner the repairs fund, which came out of the tax levy, made a good showing. It was a most vicious system; it was likewise a very expensive one. If the repairs had been undertaken the minute that defects began to show, our annual repairs would not have required an expenditure of more than four thousand dollars a year. A good real estate company owning buildings probably would have done even better. It was not a case of graft, but one of ignorance. Branigan and I were the only trustees who owned properties; the others lived in rented apartments and dwellings. For want of business experience they could not know the business as we did.

A majority of the board finally came to see that the much-lauded economy of administration had been a pitiful sham. Most of the building contractors in the city became interested in the matter, and we had their moral support. The newspapers of the city likewise took up the matter; and the controversy finally ended when the board adopted the plan which Branigan and I presented.

Summed in a single paragraph, we agreed to put all the buildings in the best possible condition. Metal work was to be inspected at short intervals and where rust spots appeared they were to be repaired at once. Painting was to be done when required and not at stated intervals. Paint on plaster was to receive as many coats as were needed. Splintered flooring was to be replaced by comb-grained southern pine—first quality for classrooms and extra first quality for corridors. The most important point was an agreement that, when a defect became apparent, it should be made good at once. For instance, if superficial cracks appear in window putty, two minutes' work with a paint brush will arrest the trouble; but if the cracking continues until water gathers behind the putty, the pane will require resetting. A rust spot in roofing may be scraped, red-leaded and painted at an expense of two or three cents; but if the repair is delayed until perforation occurs, the cost will be one of many dollars.

Preventive repair of this sort was the only true economy, and Branigan and I had learned the lesson by heart in the care of our own properties. A majority of the board saw the point, and we agreed to put the buildings in the best condition possible. For the next two years our repairs budget was pretty large, but there was no serious opposition to it. Plastered walls and ceilings beyond repair were covered with metal sheathing. So far as the ceilings were concerned, it was the proper thing; in the case of side walls, however, I am inclined now to think that replastering with cement would have been more economical. In several instances both side walls and ceilings were covered with enamelled canvas. In one of my own properties enamelled

canvas has stood for twenty years without requiring any repairs, and it looks about as well today as the day when it was put on. It has stood ten years without repair on the walls of the classrooms where it was first applied.

The replacement of splintered flooring was perhaps the most expensive proposition. Some of these floors had been laid for not more than five years. They could not be cleaned and the pupils were constantly getting splinters into their hands and feet. In order to clean the floors with the least labor, the janitors were in the habit of using strong solutions of washing soda; in order to bleach them, the lye was followed by a bath of oxalic acid. It is hardly necessary to add that this method of floor cleaning will ruin any floor in very short order; it already had ruined many of ours. The new floors were drest with oil and then waxed. In ten years they have shown but little wear, and the expense on them has been practically nothing. Teaching the janitors how to take care of the floors and how to clean them properly was a difficult matter. It required both time and immoral suasion.

The removal of varnish which had cracked and "alligatored" was an expensive job. Experience has shown that it is worse than useless to cover such a surface with fresh varnish. If the surface of the old varnish is smooth and clean, it needs only to be rubbed down and wiped clean; otherwise it must be removed if the job is to be a good one. In making a contract for revarnishing old work, there should be a specification and a specific estimate for the removal of old varnish. It is the only way to insure the best quality of work. Incidentally, when the contract goes to the lowest bidder, he is not apt to spend time and labor in preparation work. Incidentally also, the lowest bidder is the one who usually requires the closest watching.

Window sills are the chief difficulty in revarnishing. Unless the varnish be removed, the sills are apt to become black in color, the natural color of the wood being indistinguishable thru several layers of grime—poor workmanship, cheap varnish, and high cost in the end. With in-

telligent care, a well-applied coat of varnish will retain a lustrous, clean-appearing surface for many years. Window sills become soiled and kick boards are quickly scratched, but if washed and oiled when occasion requires, they keep a good lustre.

A considerable part of the outside metal work—sheathing, leaders, and gutters—required replacing; but the copper that had been in service, some of it for more than twenty years, was in good condition. The moral is obvious.

The reconstruction of the toilets was very expensive. Originally they had been well built; thru a lack of intelligent care, however, they had become disgracefully bad. They were made light, airy and clean; they were also joined to the general system of heating and ventilation. The training of the janitors to give them the proper care was not the easiest part of the work of reconstruction; our janitors were skilful politicians, and each one had a political pull.

In two years, the results of the new system began to show. The repairs budget was reduced finally to about two-thirds of the amount formerly spent for hopeless patching. What was still better, the buildings were made comfortable, and the principals were made responsible for their condition. On the whole, it was an uphill, tiresome campaign. The people who were most benefited by the change in the system were not always with us. The decrease in cost and the increase in comfort did not appeal to many of them, and a great many are still of the opinion that politics was at the bottom of the change. In due time Branigan and I quit. I remained about three years after Branigan declined a nomination; and there is no man in the city for whom I have greater regard than my old fighting partner.

Among railways the practise of establishing constants in their operative work has obtained for a long time. Maintenance, repairs and materials form about seventeen per cent of the expenditures. Reduced to a per mile basis for different main lines and branches, the per cent becomes a pretty safe constant, showing about how much should be spent to keep the road in good order. If less is spent

deterioration may be suspected; if more, there is likely to be waste somewhere or other.

Could such a scheme be worked out for our school properties? Branigan had it pretty well worked for the properties in his charge; in a way I had done so with my own. The essential feature was to make repairs as soon as defect became apparent. In the case of the school buildings there were certain obstacles in the way. To begin with, a trained man with full power to go ahead and do things is required in such a position. We might have persuaded the board to have employed a superintendent of buildings; but a political hack with his hands tied behind him would have got the job. We did not desire to be fastened to such an encumbrance. Why, then, did we finally give up trying to establish a series of constants that would apply to our maintenance expenses? One incident will show why.

A defect which was merely a slight leak appeared in the roof of a certain building. Possibly fifteen or twenty dollars would have repaired it; but not knowing what other defects might be disclosed, we asked for forty dollars. The storm broke at once. A youthful trustee whose secular occupation was mission work, let out the usual war whoop of extravagance, and, being a clever talker, carried the fight against the appropriation. Branigan and I were thoroly angered by his insinuations and the rest of the members did not seem to care about the matter at all. The appropriation was turned down. During the winter, however, the defect developed so rapidly that the building at times was flooded, and some of the classrooms became untenable. When finally the repairs were made, the cost exceeded seven hundred dollars and the real damage to the building was probably as much more.

In the course of a few years, a school board organized for efficient work can establish an annual constant of expense whereby a proper maintenance can be very closely estimated from year to year. A community gets usually the administration it deserves—perhaps not the one it really needs.

II

A STUDY OF ENGINEERING EDUCATION[1]

The chairman of this committee and others have exprest their confidence that a great deal of good will come from this study. This seems probable for two reasons: One is that it is being guided by so able and so devoted a committee. The other is that the schools have welcomed the study and shown a hearty willingness to cooperate in every possible way. Under such conditions, how can anything but good result?

Last year it was reported that the study was being carried on under four heads:

First, a historical study, for the purpose of defining the meaning of the words, American engineer.

Second, a study of the professional demand, to determine what it is that the professional engineer expects the school to achieve.

Third, a study of the schools in detail, with an analysis of their work with reference to the demands of the engineering profession.

Fourth, an investigation into objective methods of testing school work—of finding out whether men are competent to enter the engineering schools; and how effective the work is when measured by its results.

THE HISTORICAL BACKGROUND

The basis of the American system of education was laid by the general court of Massachusetts in two acts past in 1642 and 1647, respectively. These state that the aim of education should be to secure four concrete ends of great value to the church and the commonwealth. These ends were, for the church, that every one must (1) learn to read

[1] Reprinted from the *Bulletin of the society for the promotion of engineering education*, Vol. VII, 1916.

the Scriptures and the catechism, and (2) have the free opportunity of entering the ministry thru the grammar school and the college; for the commonwealth, that every citizen should learn (3) the capital laws of the colony, and (4) some gainful occupation.

At the time that this legislation was enacted the only occupations open to graduates of the college were those of minister, teacher and gentleman. The great majority of the people, including physicians and lawyers, learned their trades by the apprenticeship system. Therefore the responsibility for their education was divided between the schoolmaster and the master of apprentices. The schoolmaster was "to teach all such children as may resort to him to write and read;" and be "able to instruct youth so far as they may be fitted for the university." The master of apprentices was to train them "in some honest, lawful calling, labor or employment, either in husbandry or some other trade profitable for themselves and the Commonwealth."

This division of the function of education between the schoolmasters and the masters of apprentices was inevitable under the social and industrial conditions prevalent in the colonies. In time, however, schools came to be regarded as constituting the whole educational system, and the fact that the training of every one to some "gainful occupation" is one of the important justifications of taxation for public education, was forgotten. The magnificent service which the schools have rendered in conserving ideals in America is fully described in the standard histories of education. But the industries and mechanic arts, which have rendered a no less magnificent service in expressing American ideals and developing the American spirit, have received but scant recognition as essential elements of the national system of education. Since the industries and the mechanic arts have laid the material foundations of the United States and created the demand for engineers, it is not possible to understand engineering education without at least a brief sketch of the development of the demand that training in the prac-

tical arts be reinstated as one of the four essentials of a complete education.

The industrial history of America begins even before that of the schools. The first ship built by white men on this side of the Atlantic was launched in 1607 at the mouth of the Kennebec. A tannery was established at Lynn in 1629. In 1640 the General Court of Massachusetts directed the magistrate to consider "what course may be taken for teaching the boys and girls in all towns the spinning of yarn." By 1690 the American weavers of woolen cloth had become such successful rivals of the British weavers that Parliament past the Woolens Act which forbade the colonists from transporting woolen goods from one place to another for the purpose of sale.

"In 1718 a great stir was created in the town (Boston) by the arrival of a number of Irish spinners and weavers, bringing the implements of their craft. Directly the spinning craze took possession of the town and the women, young and old, high and low, rich and poor, flocked into the spinning school which was set up on the common in the open air. Prizes were offered for the best work and the enthusiasts went about proudly clothed in the homespun products of their own hands."

A special town meeting was held at the town house September 28, 1720, at which it was voted "that the Town will proceed to the choyce of a commitee to consider about promoting of a Spinning School or schools for the instruction of the children of this town in Spinning." This committee recommended the erection of a suitable house and the employment of a weaver "having a wife that can instruct children in spinning flax, to take care of the school." This project was not carried out till 1753 when a wheel tax was levied, £1,500 raised, and the Manufactory House built for this purpose. In 1765 the Daughters of Liberty resolved to wear only homespun, and the seniors of Harvard College agreed to take their degrees (1768) "drest altogether in the manufactures of this country."

It is a well-recognized fact that the efforts of the British

to crush American manufacturing industries were among the chief causes of the Revolutionary War. The only positive action of the first continental congress (1774) was its non-importation agreement, aimed at establishing independence in productive industry. After the Peace of Paris, under the confederation, each colony controlled its own trade. Because there was thus no concerted action with regard to industrial protection, England was able to flood the American markets with foreign goods which were sold at prices with which home manufactures could not compete. American industry was paralyzed, money became scarce in America, and the working men were idle.

To meet this situation, associations of mechanics and tradesmen were organized in various parts of the country. These took an active part in the struggle for the ratification of the constitution in the ardent hope that a federal government would be able to protect and encourage American manufactures. In this they were not disappointed for the first act of the consolidated government (1789) was a statute for the joint purposes of "raising revenue and protecting manufactures by laying duties on goods, wares and merchandise imported." The first federal patent law was past in 1790.

Not only were the manufacturers protected from foreign competition by the federal tariff, but they were also encouraged by financial aid from state legislatures. A bill levying taxes for the support of associations for the promotion of agriculture, manufactures and the useful arts was introduced into the Pennsylvania state legislature in 1798. Other states followed suit, but the first to vote funds for this purpose was New York. In 1819 an appropriation of $10,000 a year for two years was made. This state support led to the establishment of twenty-nine county societies for the promotion of agriculture and domestic manufactures during the two years.

This protection of American industry by the federal tariff and by state support seemed necessary at this time because the use of machinery and the factory system had

progrest further abroad than it had in this country. In order to maintain this advantage, Parliament had forbidden the export of machinery to America. In 1788, however, Samuel Slater, a mechanic who had had experience with the British machines, escaped to America and built from memory similar machines here. Under his direction the first successful cotton mill driven by water power was established at Pawtucket in 1790.

The invention of the cotton gin by Eli Whitney in 1792, the application of steam power to navigation by John Fitch (1790) and Robert Fulton (1808), the development of machinery for threshing grain and milling flour by Oliver Evans (1791–1804) gave great impetus to these several industries, and domestic manufactures advanced by leaps and bounds.

Great difficulty was experienced in obtaining operatives, as the manufacturers were "required to raise up an entire new set of workmen from amongst our own youth at a heavy expense." These operatives were poor children seven to twelve years old whose parents had been able to give them small opportunities for schooling. Therefore, in 1793 Slater established at his own expense, a Sunday school where these children were taught the three R's by students from Rhode Island College. These Sunday schools were the precursors of the mechanics institutes.

As the manufacturing industries developed and machinery came to be used more and more, the difficulty of securing skilled labor increased. Signs of exhaustion of the soil also began to make it evident that more intensive and scientific methods of farming must be introduced. In 1818 there was published in the *Gentleman's magazine* the first account in English of the Fellenberg industrial school at Hofwyl, Switzerland. The Hofwyl school was first established as a charitable enterprise for the education of poor children. Its work was such a marked success that the children of the rich soon sought admission too. Its aim was the development of character by all-round training. Careful attention was given to physical health and to recreation by change of

employment. Time was judiciously divided between books and the work of caring for the place. Sound morals were inculcated thru good books, good environment, self-government, no prizes, and mutual confidence among instructors and students. The plan and methods of this school seemed so well suited to the needs of the situation in America that a similar school was established the next year by Josiah Holbrook at Derby, Connecticut.

This school was not a success, but the idea spread; and in 1823 the Committee on Agriculture of the New York Legislature made a report in which the establishment of a state school of agriculture was urged. The institution was to be modeled after the Fellenberg school to consist of (1) a model farm; (2) an experimental farm; (3) a manufactory of implements of husbandry; (4) a school of industry and mechanic arts; (5) a boarding school; and (6) an institute of theoretical and practical agriculture. Arguments were adduced to show why such a school would benefit agriculture, commerce, manufactures, the morals of society, the revenues of the state, and politics.

This report closes with the remark, "Hon. Stephen van Rensselaer has offered a gratuitous deed of the lands required for the use of the institution." The legislature failed to adopt the report and the next year van Rensselaer proceeded to carry out the project alone and founded the Rensselaer Polytechnic Institute, the first engineering school in the United States. The methods of instruction introduced into this school by Amos Eaton, its first director, were original and somewhat different from those of the Fellenberg school.

At this same time the public schools reached, according to the histories of education, the low water mark of their efficiency.

The year 1824 witnessed the inauguration of another enterprise which has been of far-reaching usefulness to technical education. Samuel V. Merrick inherited that year a machine shop in Philadelphia. He soon discovered that he could not manage it intelligently without some knowl-

edge of machinery. Altho the University of Pennsylvania had in 1816 "created a new department to be devoted to the study of natural science," and altho five professors were still holding chairs in that department, Merrick was unable to get the kind of instruction he needed. He therefore decided to establish a new school. Professor Keating of the university department of applied chemistry joined in the venture. This combination of Merrick's need with Keating's knowledge proved effective. The Franklin Institute was established. One of its first students, a bricklayer named Thomas U. Walter, designed the dome of the Capitol at Washington.

From 1825 to 1860 the industries developed rapidly. Canals and railroads were built, the McCormick reaper, the sewing machine and the telegraph were invented, and the Atlantic cables were laid. The west was settled, the federal finances prospered, and state school systems were developed. Every new stage of advancement in material prosperity and every new invention served to intensify the demand for greater knowledge of science and greater skill in the useful arts. This national demand had become so insistent by 1857, that it could no longer be ignored. The Morrill bill was introduced into Congress, and became a law in 1862.

It is important to note that this response to the national demand for practical knowledge came from the federal government. State school systems had been established by each state independently and on traditional lines; but this act calls for a new American type of school "to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." It is also significant that the father of this land grant college bill was father of the tariff act of 1861, and that bills increasing the federal bounties to these colleges were introduced into Congress during the tariff discussions in 1872, 1884 and 1890.

The decade from 1860 to 1870 witnest the establishment of several of the most celebrated engineering schools. In following their subsequent development it is important

to recognize clearly that their origin was very different from that of the schools of law and medicine. These latter were first established by practitioners as an outgrowth of the apprenticeship system and were usually well developed as professional schools before they became affiliated with the colleges. The engineering schools, on the other hand, were not founded by engineers as the outgrowth of an apprenticeship system, but by college professors who sought to satisfy industrial needs by the methods to which they were accustomed in the colleges.

Yet notwithstanding this close kinship of the engineering school to the arts college, the scientific school was kept distinct from the college proper. The students preparing for an industrial profession were not considered as of the same caste with those preparing for the learned professions.

This feeling in the colleges was reflected in the public schools which were still oblivious to the fact that training for a gainful occupation is one of the four fundamental justifications of taxation for public education. The lowest depths of this oblivion were reached in the report of the Committee of Ten (1895) when languages, mathematics, history, natural history, physics and chemistry were declared to be the only subjects proper for secondary schools.

The achievements of engineering have, however, forced the recognition of the fact that knowledge of the practical arts is essential to the education of every American. The demand for vocational education is omnipresent, and the schools seem to be about ready to follow the lead of the engineering colleges in so teaching the mechanic arts that their educative power shall be felt by everyone. Since the apprenticeship system has now practically disappeared, this introduction of the industrial arts into school work is necessary before the schools can justly claim to give a complete education, i. e., one that confers all the benefits on the church and commonwealth which the founders of the American educational system had in view.

For the past fifty years engineers have been absorbed in the work of inventing, constructing, and perfecting ma-

chinery and the material conveniences of life. A large field for usefulness along these lines will always remain open to them. But the methods of this work have now been standardized and reduced to a system. Every large plant has its designing department and even its research laboratory.

Relatively little attention has as yet been given to the scientific study of problems of the organization and control of the forces of men. These problems of human machine design and the conservation of human resources are as much engineering problems as are those of mechanism and the conservation of material resources. The demand for creative work in this field of human engineering is daily becoming more insistent. Can the engineering schools longer afford to ignore it?

Again, American industry has developed in a land of abundant natural resources. It has always been protected by a tariff which has been raised as the industries grew stronger and more wealthy. This protected atmosphere of natural opulence has given strong incentive for the development of originality, initiative, and push. Every boy in America has felt that the opportunity to become president was open before him. There was, however, little incentive for economy of production. It was much easier to exploit the Indians or to persuade Congress to raise the tariff than it was to make a scientific study of production costs.

The increase in population and the waste of natural resources have now brought the United States under the operation of the law of diminishing returns. The problem of efficiency of production has been thrust upon us. This again is an engineering problem. It can not be solved here by merely copying the autocratic methods that have been used successfully elsewhere, but demands an American solution which shall insure efficiency without sacrificing individual spontaneity and initiative.

These then are the three problems of the immediate future for the American engineer: (1) To introduce the

practical arts into the schools in such a way that all may share their educational value. (2) To devise human machinery that shall assure to every American justice and a fair show. (3) To develop the highest efficiency of production—an efficiency which is attainable only when individual initiative is given the freest play.

THE PROFESSIONAL DEMAND

The returns from the circular letter sent out in the spring of 1915 were summarized and the results announced at the meeting of the American Society of Civil Engineers last January. Because of the rather unexpected nature of the summary and its importance in defining the work of the schools, the Joint Committee on Engineering Education last March sent to the members of the National Engineering Societies the following card:

> Please prefix numbers to the groups of qualities listed below to show the order of importance that you give them in judging the reasons for engineering success or in sizing up young men for employment or promotion.
>
> ....Character, integrity, responsibility, resourcefulness, initiative.
>
> ....Judgment, common sense, scientific attitude, perspective.
>
> ....Efficiency, thoroness, accuracy, industry.
>
> ....Understanding of men, executive ability.
>
> ....Knowledge of the fundamentals of engineering science.
>
> ....Technique of practise and of business.
>
> Submitted by.....
>
> Address.....
>
> Years in practise....

Up to June first, 6,773 of these cards had been returned; 352 were accompanied by letters explaining the views of the writers.

A statistical summary of the returns was begun on May first, when 6,069 cards had come in. Of these, 5,441 were regular, each one rating the six groups in the order of importance by some single combination of the numbers 1–6. There were 489 irregular cards, in which one or more of the numbers appeared more than once or in which the qualities were weighted by percentages instead of being numbered. On 139 cards the qualities were numbered in two or more different orders, one for engineering success, another for em-

ployment, and so on. The regular cards were sorted according to the number of years in practise and the vote counted separately for each five-year period. Cards on which the years in practises were not given were counted together.

Differences in years of practise were found to make but little difference in the vote. The following table gives the regular vote by ten-year periods. The table reads: Char-

	Years in Practise.				
	Under 10.	10–19.	Over 20.	Not given.	Total.
No. of ratings...	1,000	2,000	1,941	500	5,441
C>*J*.....	84.8	86.6	88.3	88.2	87.0
C>*E*.....	92.5	92.8	92.5	91.8	92.5
C>*U*.....	92.7	93.0	95.0	95.8	93.9
C>*K*.....	91.8	91.9	91.0	91.4	91.5
C>*T*.....	97.3	98.0	98.0	98.0	97.9
J>*E*.....	77.8	78.7	76.3	75.4	77.4
J>*U*.....	80.8	82.1	84.1	82.0	82.5
J>*K*.....	78.4	79.7	74.7	75.8	77.4
J>*T*.....	96.8	96.2	95.0	96.2	95.9
E>*U*.....	59.7	61.5	68.5	65.4	64.0
E>*K*.....	65.0	63.0	64.9	64.4	64.2
E>*T*.....	93.9	92.9	92.7	95.8	93.4
U>*K*.....	57.7	57.3	54.5	52.2	55.9
U>*T*.....	89.9	87.1	85.7	86.0	87.0
K>*T*.....	92.3	90.3	90.7	91.2	90.9

acter was rated higher than judgment by 84.8 per cent of the voters who had less than ten years of experience, by 86.6 per cent of those with from ten to nineteen years of experience. The last column gives the percentage vote on each item for all the 5,441 voters.

The most probable values of the relative importance of these groups of qualities have been computed from these percentage votes by the method described in Chapter VIII of Thorndike's *Theory of mental and social measurements*. These values are given in the first column of figures. The last column gives these same values as determined by the summary of the replies to the first circular letter explained in the *Engineering record* for January 29 and the *Engineering news* for January 27, 1916.

Character	24.0		41.0	
Judgment	19.5		17.5	
Efficiency	16.5		14.5	
Understanding of men	15.0	75	14.0	87
Knowledge of fundamentals	15.0		7.0	
Technique	10.0	25	6.0	13
		100		100

Because of the constancy of the percentage of the votes, as shown in the table, it is clear that this statement of the factors essential to engineering success corresponds to a rather definite ideal in the professional mind. It is therefore safe to make use of this definition in testing and planing the work of the schools.

When applying this definition to the schools it is desirable not to forget several perfectly obvious facts. In the first place, all the qualities mentioned are essential to genuine success and conscious effort should be made to develop all of them as far as possible. Second, character, initiative, common sense, and qualities of this sort can not be taught explicitly like multiplication tables and rules of grammar. Third, education is a continuous process of growth, and, therefore, the conscious development of the qualities of the first four groups can not to advantage be arrested for four years, even for the sake of a mastery of knowledge and technique. Fourth, the man whose character, judgment, efficiency and understanding of men has developed most during his college years has the best show after graduation, since these qualities constitute 75 per cent of his equipment. Fifth, the fact that character is rated at 24 per cent does not mean that an engineer can succeed with a 24 per cent character. It does mean that even a perfect character is but 24 per cent of the engineer's total equipment.

With these facts in mind it is evident that instruction in mathematics, or machine design which aims only at a mastery of fundamental principles and technique, can not be nearly as efficient as instruction which, while paying due regard to technique and the mastery of principles, yet de-

velops integrity, initiative, resourcefulness, and common sense.

THE WORK OF THE SCHOOLS

A. WHAT FRESHMEN KNOW AND CAN DO

Twenty-two schools have been visited and carefully studied. A composite picture of their work furnishes the best statement of conditions. Tests of 220 freshmen at four institutions have been conducted by Professor E. L. Thorndike. These tests furnish objectively certain facts about the human material which schools of engineering educate, showing what the members of the entering class know and can do. The following samples may serve to give some idea of their abilities.

In Algebra, nine-tenths of the freshmen were able to solve the following equation: $x - 2a + b = 2x + 2b - 4a$. Only one-third of them could solve the following: If $x = (a + b)/2$, what does

$$(x - a)^3/(x - b) - (x - 2a + b)/(x + a - 2b)$$

equal?

In Physics, nine-tenths were able to tell what materials were needed to make an electric battery. Only one-third could determine how much water must be added to a pint of alcohol 95 per cent pure to make a solution of alcohol 40 per cent pure.

Nine-tenths were able to fill the blanks in the following: Light generally travels in .... lines. 100 Centigrade degrees equal 213 Fahrenheit degrees. Only one-third could correctly supply the missing words in: The mechanical advantage of a system of pulleys, provided no energy is dissipated inside the pulleys, is .... the number of .... of the cord supporting the load. When a mass of air is heated .... its volume increases 1/273 of its value at zero degrees for every rise of one degree C. in temperature.

English.—In English, nine-tenths could classify as animal, flower, boy's name, book, something good or bad to be or do, the following words: zachary, dexterous, hyacinth, clematis, callous, mastodon, caribou, julian, ruthless.

Only one-third could similarly classify: predatory, breviary, sophistical, campanula, pusillanimous.

Nine-tenths could fill in "A body of ..... entirely surrounded by .... is called an ....."

Only one-third were able to make sense out of "Let us briefly examine the social forces ..... at work concentrating or ..... the ownership ..... wealth."

Nine-tenths could write the answers to the questions on the following paragraph:

"It may seem at first thought that every boy and girl who goes to school ought to do all the work that the teacher wishes done. But sometimes other duties prevent even the best boy or girl from doing so. If a boy's or girl's father died and he had to work afternoons and evenings to earn money to help his mother, such might be the case. A good girl might let her lessons go undone in order to help her mother by taking care of the baby."

1. What is it that might seem at first thought to be true, but really is false?.....

2. What might be the effect of his father's death upon the way a boy spent his time?

3. Who is mentioned in the paragraph as the person who desires to have all lessons completely done?

Only one-third could answer the questions on the following:

"A chief characteristic of science, then, is that in supplementing given facts it supplements them by adding other facts belonging to the same sphere, and eventually discoverable by tracing the given object in its own plane thru its continuous transformations. Science expands speculatively, by the aid of merely instrumental hypotheses, objects given in perception until they compose a congruous, self-supporting world, all parts of which might be observed consecutively. What a scientific hypothesis interpolates among the given facts—the atomic structure of things, for instance—might come in time under the direct fire of attention, fixt more scrupulously, longer, or with better instruments upon those facts themselves. Otherwise the hypothesis that assumed that structure would be simply false, just as a hypothesis that the interior of the earth is full of molten fire would be false, if on inspection nothing were found there but solid rock. Science does not merely prolong a habit of inference: it verifies and solves the inference by reaching the fact inferred. The contrast with myth at this point is very interesting; for in myth the facts are themselves made vehicles, and knowledge is felt to terminate in an independent existence on a higher or deeper level than any immediate fact; and in this circumstance is what makes myth impossible to verify, and, except by laughter, to disprove."

1. According to the paragraph, what is the difference between the ether, the electrons or lines of electro-magnetic force and angels, a sun-god, or fairies, as principles of explanation?

2. According to the paragraph, by what sort of explanation of the facts of the world are the facts themselves made mere carriers of thought to conclusions in a realm outside that of such facts?

3. According to the paragraph, what are the methods and instruments by the aid of which perceived things and qualities are made the basis of a consistent independent universe?

B. WHAT THE SCHOOLS DO TO FRESHMEN

Two thousand freshmen of the type described entered a group of schools in the fall of 1911. Of these 732 graduated in June, 1915. The other 1,268 had been "weeded out."

The records of the 732 who graduated from the 14 different schools showed that 382, or 52.2 per cent, just "got by" in physics, 52 per cent just past in mechanics, 45 per cent in calculus, 43.7 per cent in modern languages, 43 per cent in English, 34 per cent in chemistry, and 23 per cent in descriptive geometry. These averages for 14 schools do not differ materially from those presented last year for five schools.

There are many who maintain that these conditions are most encouraging; for the fact that only one-sixth of those who enter graduate with credit proves that the schools are maintaining high standards. This position would be more readily understood by the critics of the schools, who constitute the great majority of the American public, if the term standards were more clearly defined. What sort of standards are being maintained by this process? Are they standards of scholarship, standards of academic culture, standards of engineering efficiency, standards of justice, of integrity, of morality, of common sense, of accuracy, of science, of art, of freedom of achievement, of worldly success, of unity, of service, of obedience, of duty, of law and order, of aristocracy, of democracy, or of humanity? Perhaps all of these and many more are meant. It would be a real service if the exact meaning of the phrase "maintaining standards" in schools might be accurately defined.

On the other hand those who consider that this high scholastic mortality and these high percentages of low grades are proofs of the inefficiency of the schools offer many hypotheses in support of their position. Among these, two are

particularly suggestive. The first of these is derived by analogy from the experience of the industries with "soldiering." Under the old industrial system, workmen are paid according to the number of hours of work, and little attention is given to the amount accomplished per hour. Under this system the workman accomplishes as little as he dares and unions are formed to raise the time rate and to standardize this minimum accomplishment. When the reward is measured solely by time and not by achievement, there is every incentive not only for laziness but even for deliberate deception of the employer as to how much can be accomplished per hour by a willing and properly instructed workman.

The school system is analogous to this old industrial system since it awards credits in accordance with Commissioner Finley's table of academic weights and measures, namely:

45 minutes make 1 hour
5 hours make 1 week
36 weeks make 1 unit
'15 units make 1 matriculant
120 semester-hours make one degree

The student who puts in the requisite time with an estimated efficiency of only 60 per cent receives the same credit as one who achieves an efficiency of 100 per cent. The result is similar to that in the industries—many students soldier, try to bluff their way thru and even unite to create the tradition that it is a disgrace to be rated much above the pass mark.

In the industries this situation has been met first, by making a careful, detailed, scientific study of all the conditions that affect efficiency; second, by instructing the workmen in the best methods of work; and third, by making the reward depend on accomplishment. Where the old industrial system has been replaced by this new system, in accordance with the principles enunciated by Mr. F. W. Taylor, soldiering has disappeared, the workmen have doubled or even quadrupled their achievement, their earnings have increased, and they have become more contented and more healthy.

The success of this change of policy in industry makes us wonder whether an analogous change might not prove equally beneficial to the schools.

Usually the method of presenting subject matter in schools is determined by the teacher's conception of logical rigor and theoretical unity. In spite of the fact that the high percentages of failure and low grades prove that this method is not effective, very few experiments have as yet been made to find methods better adapted to the abilities of the students. But if the same scientific care were used in setting tasks in schools as is used in setting tasks in industry, would not these conditions improve rapidly? And would not school grades be a truer measure of ability if tasks were graded from easy to difficult and credits were given as is done in industry only for those actually completed?

Is it not probable that this system of awarding credit on the basis of achievement rather than on the basis of time would give to students a real incentive for real accomplishment as it has to workmen?

Industrial managers not only spend hours and days of study in adapting the task to the workman; they take great pains to see that each worker is carefully instructed in the most efficient methods of doing his work. May it not be that more time could be spent to advantage in instructing students in the most efficient methods of doing their work instead of leaving them to devise their own methods of study?

Thus the first hypothesis that is suggested to explain the high mortality and excessive percentages of low grades is that the method of awarding credit on the basis of time, the acceptance of a 60 per cent standard of accomplishment and the assignment of tasks that are not adapted to his abilities give the student no adequate incentive to achievement and encourage him in soldiering and in bluffing his way thru.

Soldiering alone does not explain all the cases of failure and low grades. Many of those who are dropt from engineering schools should be dropt because they have no real inclination or ability for engineering work. A number of

those dropt, however, persist in engineering work and succeed in spite of their academic shortcomings. Why are so many young men with pronounced engineering talent unable to make good in the engineering schools?

In one school some 74 per cent of the graduates had had trouble in mechanics. The work of the class consisted in the solution of many problems—apparently an excellent plan. But the first problems of the course were these: Find the center of gravity of an equilateral triangle. Find the center of gravity of the area included between three sides of a square and the semicircle described on the fourth side as a diameter. Find the center of gravity of the area bounded by a given hyperbola, its asymptotes and given coordinates. No models were supplied.

The use of these strictly Archimedean problems was defended on the ground that the analytical processes involved in their solution were those needed the following term in the solution of problems in strength of girders. Yet 74 per cent of these same students had trouble with this later course.

Why not give the real problems first? In the University of Washington, the course in mechanics, given by Professor C. C. More, is made up almost entirely of a series of real problems or projects of the grade usually found in such courses. This work was originally given in the third year because calculus was a prerequisite. The third-year men have, however, mastered it so readily that next year it will be given, calculus and all, to the freshmen. In like manner Professor Bird, of the University of Virginia, finds that laboratory problems very similar to those given in other schools, to seniors in chemical engineering, can be successfully mastered by freshmen.

These examples define the second hypothesis that is suggested to explain the high percentages of failure and of low grades; namely, the work is not too hard, but it is presented in so abstract a manner that it has little or no meaning to the students.

If these hypotheses are correct, the problem before the schools is that of removing these two causes of failure. To

do this, academic credit must be made to depend directly and objectively on achievement; and the work must be made more concrete.

This statement has been derived from an analysis of the work of the schools. Yet the problems which it defines are the same as those defined by the history of the engineering schools. For when the practical arts are introduced into the schools in such a way that all may share their educational value, the work becomes concrete and impelling to the student. And when academic credit is awarded on the basis of real achievement, efficiency and individual initiative increase together.

The solution of these problems will require much careful experimenting and study on the part of teachers; but as progress is made the schools will find that they are each year better able to meet the demands of the engineering profession. For character, judgment, efficiency and an understanding of men—those personal qualities that make up 75 per cent of the engineer's equipment—develop best in men who love their work and who labor with enthusiasm and intelligence at things which they know to be worth while.

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III

MATHEMATICS: A GREAT INHERITANCE[1]

The word mathematics, it is safe to wager, has a pleasing sound to comparatively few persons. To many, when circumstances force them into a polite semblance of attention, it is usually a signal for retiring into some inner chamber of thought where the walls are hung with more personal and less definite tapestries. Some few even have to exert considerable self-control when the subject is mentioned, so strong is their impulse to escape. The responsibility for this attitude lies partly, perhaps, with those who most appreciate the power and the beauty of mathematics; for they rarely address themselves, outside of the classroom, to any except the few who have begun to care about it. Occasionally, if they behave like the *Ancient mariner* and persist in gaining the ear, not only of those who are inclined to love the subject, but of those who merely endure it or wish to avoid it, the really compelling interest of our great legacy of mathematics makes itself felt. One has only to unfold this inheritance from the earliest ages of mankind and show how it has developed and increased century after century in forms and instruments which met as best they could the practical demands of the times, furnishing ever new and accumulating capital with which to build the civilization of the future, in order to obtain a sympathetic hearing.

Few people think of mathematics as such a great continuous whole. They see it only in part, when they are willing to look at it at all; for unless one knows a good deal of mathematics pretty well in detail, it is impossible to get such a general survey of any branch of it as one can of the literature of a people or the history of a period. The

[1] Lecture given to entering students at Wellesley College, September, 1915.

continuous strands of mathematics and the way they support our every-day activities are as impossible for any but the expert to unwind as for a child to realize the invisible currents of electricity that enable him to hear his father's voice over the telephone. Gems of art we can see, splendid paragraphs of literature can delight our ears, but the subtle beauties of the laws and combinations of mathematics make almost no appeal to the senses. It would be useless to dangle before the eyes of any but the experienced mathematician the spiral of Archimedes, the Witch of Donna Maria Agnesi, the probability integral, a determinant of infinite order, the definition of the transfinite cardinal Aleph-Null, a Steinerian or a Cayleyan, the hyper-geometric series, or the shadow of a fourth dimensional figure. These would be meaningless without some preliminary study and investigation.

Evidently it is no easy task to set forth the priceless value of this great fabric of mathematics when few readers have traced more than two or three of the oldest motifs. Yet one may attempt to spread out and show the possibilities of this wonderful heirloom, woven with the experience and embroidered with the imagination of the ages, signed here and there with many a mighty name.

Can you imagine that once upon a time there was no arithmetic or algebra or geometry? Yet every primitive race and tribe had to face certain simple problems of number and measurement. Fathers had to provide for families. Mothers, we may be sure, wanted to know that their children were all in at night. These early communities all met their difficulties in much the same way. All invented some more or less restricted system of counting; some numeral words and symbols so that they could exchange number ideas; some rude forms of measurement for building a shelter, feeding a family, or dealing with time and distance; and some way of expressing quantities of one kind in terms of another for purposes of trade. They all had some notion of addition, and often more than that; for life, even in prehistoric times, was not just addition and subtraction.

Division and fractions forced themselves into notice, tho they were most unpopular. A man who could manage fractions was regarded as more or less of a wizard. The papyrus of Ahmes, the Egyptian priest who, about 1500 B. C., wrote a book called *Directions for knowing all dark things*, dealing chiefly with fractions, sounds very like an incantation and brings home to us the difficulties which fractions presented to the early races. No one can say how long it took or how difficult it was to develop this amount of mathematics, an amount which small children fairly easily make their own today. It was the result of the hard study and the happy inventions of the wise men and the wise women in isolated primitive tribes over centuries of time; and the struggle apparently differs not in kind but in degree from the efforts to enlarge the borders and applications of mathematics at the present day.

In those early days it is safe to assume the existence of the same revolt as now against unnecessary labor. All over the world, among all the isolated peoples, men avoided mental arithmetic and turned to the natural counting machine which they had literally at their fingers' ends. With few exceptions, and these only a variation of the process, primitive men have counted up to ten on their fingers, and then, if their systems went further, used groups of tens and the powers of ten. Imagine them counting up to ten, then putting down a pebble, notching a stick, or having a second man hold up a finger while they counted another group of ten, and so committing us to our decimal system of enumeration. Counting on the fingers seems, with this historic background, a perfectly dignified operation. Why should we refuse to use this machine for checking up small numbers and go to an electric adding machine for summing large ones?

After counting, or along with it, somehow or other there developed ideas of representing numbers in different ways. The scout who piled up pebbles, one for each of the enemy, to show the following war party how many there were in the enemy's band, was using the great principle of one-to-

one correspondence that lies behind all numeral representation, tho he was unconscious of the principle, we may be sure. The abacus, the wire frame with sliding balls that is a memory of our early struggles with arithmetic, was an invention that made possible a great advance in the processes of representing and combining numbers. Used in remote centuries by the Chinese and in Europe down thru the Middle Ages, it is still employed in European banks in the East for checking accounts. Thru this medium came the invention of our powerful decimal notation, depending on the position of digits, but it had to await the ideas of the relating of symbols to columns of balls on the wires, the significance of the order of the columns, and the importation of the symbol zero to stand for an empty column from the Hindu mathematicians thru the Arabs. It was not until 1350 A.D. that Europe really took possession of this powerful instrument, the positional decimal system, without which we should be helpless before our own small numeral problems, to say nothing of those of science, government and finance.

Thru the ages certain conditions have been favorable to the growth of mathematical knowledge, and it meant much to mathematics to have such a civilization develop as that during the Greek domination of the Mediterranean basin. Antiquarians, anthropologists and missionaries find few traces of any knowledge of mathematics beyond the mere elements among isolated groups of people such as the South Sea Islanders, the North American Indians and the Esquimaux. But when Greece controlled the Mediterranean a variety of races exchanged and developed ideas as well as commodities, and an increasingly complex civilization made new and clamorous demands upon mathematics to explain the physical universe and to serve the practical arts. Mathematics simply had to respond. Arithmetic was not popular with the intellectual leaders of Greece: it savored of Phoenician trade and did not fit in well with other mathematical interests. Geometry seemed to suit the Greek mind best, and the kind of geometry

they developed with such keen delight has had little of importance added to it since the days of Euclid, 300 B.C.

It is amazing to think of the way ideas traveled up and down the Mediterranean coasts from the time of Thales, six centuries before Christ, to Diophantus, nearly four centuries after Christ; the wonderful minds in which they fertilized and developed; the joy and interest with which they were received and fostered; the faint prophecies of some of our latest modern inventions here and there. Perhaps these are only fables, but one likes to think that Archytas was fond of children and invented a flying toy, a forerunner of the aeroplane; that Pythagoras sacrificed a hecatomb to the gods when he discovered the proposition that the square on the hypotenuse is equal to the sum of the squares on the other two sides; that Euclid was so annoyed when a student asked him what was the use of studying geometry that he bade his slave give the boy some coppers, "since," said he, "you must have profit from what you learn;" that Alexander the Great was so impatient to get thru his geometry and, as a modern young man would say, "get into business," that his tutor Menaechmus had to warn him, "Sire, in the country there be some private, and even some royal roads, but in geometry there is but one;" or that Archimedes, when at the bath, hit upon a plan for discovering whether the golden crown made for his patron, King Hiero of Syracuse, contained all the gold the king had given the jeweller, and rushed thru the streets to his laboratory, crying "Eureka—I have found it."

The mathematics of those days is a strong, substantial part of our inheritance and the greatest mathematicians have been the quickest to acknowledge its worth. For the Greeks established firmly the mathematics that their day and generzation needed to use and had an intellectual interest in. If progress had not been hindered by the lack of interest of the Romans, by the general disorder of the Middle Ages, by the loss of Greek mathematical literature until the fall of Constantinople in 1453, and by the fact that monastic research was directed more toward such problems as the

number of angels that could stand on the point of a needle than toward formal arithmetic, we might not have had to wait until 1600 A.D. for the powerful modern methods that have so advanced mathematics in the last three hundred years.

Since 1600 many new processes and patterns and materials have been woven into mathematics. We have added the so-called negative numbers, tho for a long time, as Bhaskara, the Hindoo, said in the twelfth century, "Most people approved them not." We have also annexed imaginary quantities, infinites and infinitesimals, and have invented the shorthand of symbols that enables us to describe and combine them in a way that would astonish the ancients. We have accomplished this largely by making stupendous generalizations, by daring to assume certain great principles without knowing where or how far they were going to lead us, the principle of continuity and the principle of no exception. We have in particular demanded means for dealing with quantities in motion rather than at rest as did the Greeks. We have wanted to see quantity as a moving picture and not as a Greek statue. That desire, on the whole, lies behind all our modern methods.

A student entering college might realize the great difference between ancient and modern mathematics more clearly were I to say that if he held a certificate from Euclid or Apollonius or Archimedes (tho the latter would hardly have devoted time to student preparation) to the effect that he had completed Euclid's *Elements* satisfactorily, he would be sufficiently well prepared in geometry, tho he might never have heard of some of the theorems the present-day student has worked out as original exercises. These tutors would have been available by the third century before Christ, but no tutors in algebra could have been found so early. In the ninth century A.D. he could have learned to cipher (an Arabic word, as is also algebra) at Bagdad, when Haroun-al-Raschid of Arabian Nights fame was encouraging the pursuit of mathematics and other learning at his court. He could not have become expert in using our modern notation before that time.

Bhaskara, the Hindoo, born in 1114 A.D., would have been a splendid master. Caravans to India played the same part in spreading mathematical ideas as the ships of the Phoenicians, and there is no doubt that Bhaskara was well versed in the mathematics of the Greeks and the Arabs. He probably drilled many students in problems in square and cube root, simple arithmetical progressions, and even quadratic equations, tho he would not have been a harsh critic when negative and imaginary solutions were ignored.

For preparation in the Binomial Theorem and its applications, the first available master would have been Newton, after the year 1665, and he might have allowed a student to use Pascal's Triangle for writing down the binomial coefficients, a device Pascal had published in 1653. To use imaginary quantities fearlessly one would have had to wait for the explanations of Argand and Gauss in the early 1800's, and to have had a master who could make one feel that surds and such incommensurables as π were perfectly proper quantities one would have had to wait for Dedekind in 1870. So recently as that did these queer aliens obtain their passports as genuine algebraic citizens.

Thru the ages the extensions of mathematics in one direction have immediately led to extensions in others. The reactions of algebra upon geometry and of geometry upon algebra, beginning with Descartes' invention of coordinate geometry in 1600, have been most fortunate in their results, and one discovery after another has been made just in time to afford some great mind the necessary material for an epoch-making combination. Geometry had incommensurable lines in the days of the Greeks, but they were frowned upon until algebra offered an explanation, or an analogy, in incommensurable numbers. Copernicus (d. 1543) showed the simplicity of conceiving the planets to revolve about the sun in nearly circular orbits. Kepler followed and in 1609 proved that they moved in almost circular ellipses. The material was then ready for Newton to apply his laws of motion, under the hypothesis that the sun attracted a particle inversely as the square of its distance, and thus

established gravity as a universal force, the behavior of which could be mathematically exprest.

Mathematics became largely algebraic when the engineer, the navigator, the astronomer, the military and naval expert adopted the equation and infinite series as tools, and demanded that the mathematician should develop whole new fields and processes for working in them, in particular the expression of geometric forms by algebraic equations. The developments under this imperious behest have been most fruitful and far-reaching; and, strangely enough, the work of the isolated student in the realm of pure theory has often been applied in fields he never dreamed of. Poincaré, the great French mathematician, whose work ended so prematurely in 1914, says "If we had not cultivated the exact sciences for themselves, we should not have created mathematics the instrument, and the day the call came from the physicist we should have been helpless." In 1901 the English Clifford said, "No advance seems likely in molecular physics until more mathematics is invented." As an instance of the way a chance investigation may lead to a great theoretical discovery, we have the case of the French gambler, Chevalier de Méré, in the 17th century, who asked Pascal to give him a rule for dividing the stakes when a game was left unfinished. Pascal, and after him Laplace, formulated the ingenious rules of choice and chance and the theory of probabilities which have become the foundation of all insurance business and of the statistical methods of the biologist, the sociologist and the meteorologist. The visionary imaginings of the theorist in one age have been crystallized into wonderful implements in the hands of some practical successor, and the power furnished to the practical arts has made the craftsman redouble his demands.

Mathematics has become a necessity in our daily life at the present time. To realize our dependence upon modern mathematics, to understand what it would mean to make ourselves contemporary with Descartes and Kepler in 1600 A.D., we need only lay aside our Arabic nota-

tion and attempt to multiply, let us say, 249 by 307 in the Roman style and with Roman numerals; or we need only think of how upsetting it would be to remove our postal, telegraph and telephone facilities at a moment's notice to obtain some idea of the way it would handicap the scientist, the craftsman, the financier, the economist, the investigator, to remove modern mathematics. Astronomy without the calculus would be little more than the astrology of the Middle Ages; the triumphs of modern engineering would be impossible; we could not plan the range for coast defence guns; we could not direct a steamer in a fog, an aeroplane above the clouds, or a submarine under the water; and the whole field of large business which depends on averages and the theory of probabilities would be unmanageable. So inextricably, altho to most of us unconsciously, have we founded our modern life on mathematics.

Modern men and women may be convinced of the practical value of mathematics to present-day civilization and incidentally to themselves, and yet see no reason why they should personally interest themselves in mathematical theory beyond the common elements, or subject themselves to the severe mental discipline that is needed to insure firm handling of mathematical method. Obliging clerks, carpenters, plumbers and dressmakers will solve the geometrical and mechanical problems of their daily life; they can play tennis without derivatives, and keep a bridge score without the theory of equations; brokers will make for them the logarithmic computations that attend investment in bonds; at a moment's notice life insurance agents will make out a schedule for them with no least hint of the conditions set by the law of probability; real estate agents will see that the necessary trigonometry has been applied to secure a firm title to real estate; why should one go beyond elementary mathematics one's self? In 1693, when mathematics at Harvard College consisted of arithmetic and geometry in the senior year, it was very easy to acquire all the mathematics that the average well-educated person was expected to understand; but since 1867 colleges of the first rank

have asked for considerably more than that for entrance. Most of them appreciate mathematics so highly that they ask their students to pursue the study one year in college, and the reasons for this appreciation in education throw further light on the essential value of our inheritance.

College students do not continue their study of mathematics merely for training in accuracy and precision, even tho the calculations performed may lead to great expertness in these respects. To use the science of mathematics for this purpose alone, or even chiefly, would be like using Pegasus for a plough horse, especially when so much calculation can and should be done by machinery and tables. Professor Keyser of Columbia has said, "Mathematics is no more the art of reckoning and computation than architecture is the art of making bricks or hewing wood, no more than painting is the art of mixing colors on a palette, no more than the science of geology is the art of breaking rocks, or the science of anatomy the act of butchering." One's pride in perfection of achievement requires that mathematical work be correct and finished in result and appearance; but so should it be in every other subject. The precision and accuracy of mathematics is just one kind of precision and accuracy, and to add to one's elementary mathematics the introductory theory of limits, infinite series, calculus, determinants, logarithms, equations, modern trigonometry, and similar topics will not add greatly to one's mechanical skill.

The probable gain on the mechanical side is a feeling for short cuts and symbolic devices, with an increase in ability to invent and use them. For the difficulty of mathematics is a stimulus to short cuts, one of the great demands in present-day problems. The mathematician hates to repeat a hard and tedious calculation and is always on the alert to formulate a general scheme or substitute a process that will be quicker. He invents multiplication to take the place of continued additions of the same number, logarithms for computing powers and roots, and determinants for the solution of simultaneous equations. It is ever his habit

to use mechanical devices in order to free his mind for new and important computations and discoveries. It is worth while for all of us to form this habit and also that of easily using type forms and symbolic methods. Modern thinking is so constantly handled by symbols that grow more and more stenographic, that the almost completely symbolic method of modern mathematics gives on the whole the strongest general technique in that respect.

This mathematics is also a great imaginative realm. It demands imagination of its followers, and it bestows imagination upon its devotees. Voltaire once said, "There was far more imagination in the head of Archimedes than in that of Homer;" and Hermite, the French mathematician, advised that children be nourished with fairy-tales as the best preparation for mathematics. Upon those who acknowledge the beneficence of mathematics under its possibly grim exterior, it will, like the fairy godmother of old, bestow the joy and power of mathematical invention and the ability to apply its method in any realm at pleasure. For the ability to use the known to prove or construct the unknown is an ability that counts in working with any material, in any science or in any art.

To deal with the world as one meets it today one is constantly forced to generalize. We need to acquire the faculty of ordering vast collections of phenomena and deriving general principles. This is the essential atmosphere of modern mathematics, the instrument which replaced eighty-three geometrical propositions of Apollonius' Conic Sections by one algebraic equation. An artist, who observed a multitudinous variety of spiral forms in nature and in art and who was led to mathematics in his search for a general formula to describe them, rates mathematics first in this respect. He says "No finer instrument than the higher mathematics was ever conceived for enabling the human mind to grasp the unity of apparently complex phenomena." The student of mathematics can hardly fail to be affected by this atmosphere.

What mind is more powerful and original than the one

that has been trained to trace relations and express the similarity that often exists between objects and events which outwardly show little of the qualities and conditions they have in common? To gain a mastery of the branch of mathematics which connects an equation in x and y with the path traced by a moving point in a plane, or to resolve the connection between the incommensurable π and the number of persons in a specified group of given age who will be alive at a given time, amazingly enlarges and strengthens this faculty. John Fiske, the historian, has said "The ability to imagine relations is one of the most indispensable conditions of all precise thinking. No subject can be named in which it is not imperatively needed; but it can nowhere be so thoroly acquired as in the study of mathematics."

Mathematics has even been called the science of relations; in other words a science that has no concern about the material it is dealing with. This is the view of Bertrand Russell, perhaps the foremost English enquirer into mathematical philosophy. He says "If our hypothesis is about anything and not about some one or more particular things, then our deductions constitute mathematics," and he goes on to give that startling definition of mathematics which always pleases those who love it not, "Thus mathematics may be defined as the subject in which we never know what we are talking about nor whether what we are saying is true."

Yet whatever is said in mathematics must be clear and definite and consistent, or it is not mathematics. "Mathematics has no means for expressing confused ideas," and we are constantly exercised up to the full limit of our powers of clear expression when we attempt to state mathematical ideas or furnish a proof that is mathematically correct.

To my mind mathematics, if we fully claim our inheritance, almost forces us to develop a sense of proportion, a grasp of details and power to marshal them, constructive ability, a feeling for relations, the power to distinguish the large from the small, permanent from transitory values, essential qualities from superficial. And these are all

mental weapons that we need for attacking the problems we face in every human relation and in every walk of life. When, however, we take over even a little of the modern portion of our mathematical inheritance, it seems to me we secure two advantages which should be placed before all these. The first is that we enter a more mature world of thought, really grow up to the measure of our generation. Some subjects and experiences make one mature in information, chiefly; others, as mathematics, chiefly in method. The mathematics of the ancients, our elementary mathematics, is in a sense the mathematics of childhood; its method applies to finite and visible phenomena. The ancients were frightened by the invisible quality of incommensurable lines that involves infinity and kept algebra and geometry apart for fear of disaster. The maturer mathematical mind seeks eagerly an explanation of the infinitely large, the infinitely small, the invisible continuities and relations of quantities: it is daring and resourceful, and it has confidence in, and is exhilarated by, the great hypotheses it has assumed. The one method does for the simple life of the ancients: the other is needed by each one of us for the intricacies of modern physical and mental relations. "A type of thought," says J. W. A. Young, "a body of results, so essentially characteristic of the human mind, so little influenced by environment, so uniformly present in every civilization, is one of which no well-informed mind today can be ignorant." To have a proper share in the intellectual inheritance and life of our generation, really to think as a modern, to have proper standards of appreciation and the familiarity that culture demands with great achievements and their uses, we can not in this twentieth century abandon any great department of knowledge with the discoveries of the seventeenth century. I say seventeenth century, for on completing the ordinary high school mathematics one has hardly reached the age of Newton and the Binomial Theorem. We need to pass beyond the childish and medieval modes. We must learn to organize and relate and generalize in the modern analytical fashion, the fashion that mathematicians have so consciously

adopted in the last hundred years that you can not enter one of their great domains today without having these methods fairly forced upon you, without being disturbed in any comfortable habits you may have acquired of making snap judgments of persons and events, of seeing only what is on the surface, of easily taking things for granted.

The second of the superior advantages is the way in which mathematics can help one to put one's personal intellectual domain in order, and bring one to that supreme height of culture where one has, on the whole, ordered one's experiences in various realms with due proportion, harmonized one's tastes, and organized one's ideals and principles into a well-related whole. Strong, keen, delicate, flexible tools for this triumph of spiritual construction are forged to perfection in the mathematical workshop. Men and women who have a firm and broadly consistent personal policy, that nowhere infringes upon the rights of their neighbors, have, I am convinced, used mathematical methods and principles to construct it, tho the tools may have been used with the same unconsciousness with which they apply them or benefit by them in more practical realms.

Even tho it is difficult to enter into such masterful possession of our great mathematical heritage, shall we not admit that there is a compelling necessity to understand this accumulating treasure of the ages as we do any other great achievement of the human race; that we can not be sure of being in intellectual tune with our generation if we have not investigated and made somewhat our own the great modern principles and methods of mathematics; that for our own mental health and progress we need to have learned to think in the modern mathematical way? We shall find, if we earnestly pursue mathematics, that it is not all hard, dry, monotonous work. There is a lasting pleasure in discovering universal qualities, in sharing the mental progress of the ages, in tracing the beginnings and verifying the applications of the great principles of mathematics.

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IV

VARYING CREDIT BASED ON QUALITY OF WORK

In October, 1909, the National Conference Committee on Standards of Colleges and Secondary Schools formulated and adopted the following definition of a unit: "A unit represents a year's study in any subject in a secondary school, consisting approximately of a quarter of a full year's work." This definition is now regularly employed by the College Entrance Examination Board, the Carnegie Foundation for the Advancement of Teaching, and many other educational organizations. In the standards of accrediting secondary schools of the North Central Association a unit course of study in a secondary school is defined as "a course covering an academic year that shall include in the aggregate not less than the equivalent of one hundred and twenty sixty-minute hours of classroom work, two hours of manual training or laboratory work being equivalent to one hour of classroom work." The Association makes the explicit recommendation that more than twenty periods per week for a pupil should be discouraged.

There is abundant and increasing evidence of dissatisfaction with this formal definition of the unit in terms of time. This definition has tended to fix attention upon quantity to the neglect of what is quite as important, the quality of school work. No one will seriously question that the kind of intellectual habits developed by pupils is a more important consideration than the content of courses or the time spent in the classroom.

Observation of current school practise reveals the fact that the unit as now defined has undergone a process of dilution. From the recommendation of the Committee of Ten that sixteen periods of prepared work per week should

represent the normal work of the secondary school pupil to the rather mild recommendation of the North Central Association that more than twenty periods should be discouraged we have documentary evidence of the change that has taken place. The fact is that the normal practise is now to allow pupils to undertake more than four units of work in a year. The Chicago high schools require seventeen units for graduation. It is not unusual to find pupils taking five unit courses and extreme cases may be cited of pupils taking six or even more unit courses in a year. If this practise were confined to pupils of exceptional ability and earnestness the situation would not be so bad but school administrators know that pupils who undertake these excessive amounts of work are quite as likely to be those who have failed to accomplish the normal amount of work in previous years and hope in their last year to make up what they have already failed to do or those who shrewdly desire to have a margin of safety in case they fail in one study. This tendency, so plainly to be discerned, could not fail to lower the standard of attainment in the various courses in quantity as well as in quality.

There are other factors which are not pertinent to the main purpose of this paper, but which are worthy of passing mention as affecting the validity of the qualitative definition of the unit, such as the practise of allowing pupils in the upper years of the high school to take elementary courses in foreign language, mathematics, and such subjects, with classes composed mainly of less mature pupils, and of requiring the same number of periods for small classes in advanced subjects as are required of large classes in the more elementary courses. That these tendencies are introducing elements which demand careful consideration is seen in the recent report of the North Central Association Committee on the reorganization of the high school and the definition of the unit.

For the purpose of emphasizing quality of work in distinction from mere quantity, what may be called an administrative device has recently been adopted in a number

of schools, commonly referred to as the credit for quality method of assigning credit. This consists in the employment of a varying scale of credit to be assigned on the basis of grades secured, involving a penalty for the lower passing grades and a corresponding excess for the higher grades. This practise has been employed by several high schools in Illinois, notably the Cicero Township, De Kalb Township, Decatur, and University High Schools. A considerable number of schools in this and other states have recently adopted the plan.

The exact methods of assigning credit vary somewhat in these different schools. The Cicero and De Kalb High Schools have a common and elaborate plan, which gives pupils certain honor points as well as course credits. There is a maximum possibility of nine honor points for pupils who have a grade in any given course between 98 and 100. From this maximum there are successive stages down to zero honor points for grades between 75 and 78. Below 75 there are minus honor points, reaching a maximum of —6 for a grade between 60 and 64. Honor points give a student honors and high honors. One who is an honor pupil for four years receives five credits toward the 170 required for graduation; one who receives high honors for four years receives ten credits toward graduation. One who receives honors or high honors for four years is, for each unit of high school work completed beyond fifteen units, recommended for advanced standing in the college or university which he enters.

The Decatur high school plan is much simpler, and consists of giving 1.1 unit credit for work of high grade, an even unit credit for work of medium grade, and .9 unit credit for work of low grade.

The plan employed at the University High School gives credit varying from 1.25 units for the highest grade to 0.85 unit for the lowest passing grade. The operation of this plan can be understood only when examined in connection with the requirements for graduation from the school. These are as follows:

The following groups of courses are offered:

Group I, English
Group II, Foreign Language
a—Latin
b—Greek
c—French
d—German
Group III, Mathematics
Group IV, History
Group V, Science
Group VI, *a*—Shop work
b—Drawing and design
c—Domestic science
d—Household art
Group VII, Music
Group VIII, Physical training and hygiene

For graduation 16 units are required, of which 9 are specifically required and 7 are elective.

Specific requirements.—The 9 units specifically required are as follows:

English	3 units	History	1 unit
Foreign language	1 unit	Science	1 unit
Mathematics	1 unit	Group VI	1 unit
		Physical training and hygiene	1 unit
		TOTAL	9 units

Elective courses.—The 7 elective units must be selected in compliance with the following requirements:

1. In addition to the requirement in English, there must be offered from Groups II–VI one major sequence of 3 units from one group, and two minor sequences of 2 units each from two other groups.

2. Two sequences may be offered from Group II, but from no other group.

3. Not more than one unit each may be offered from Groups VII and VIII. Credit for courses is assigned according to the following plan:

The passing grade is 60. Grades are given only in multiples of five from 60 to 100. The amount of credit assigned for a course varies with the number of hours and with the grade received. For such courses as drawing, design and shop work, in which no preparation outside the classroom is required, one-half the amount of credit is given for the same number of hours as in other courses. In courses with daily recitations requiring preparation, credit for one year is given as follows:

A+ (95)	1.25 units	C+ (75)	1.00 units
A (90)	1.20	C (70)	.95
B+ (85)	1.15	D+ (65)	.90
B (80)	1.10	D (60)	.85

For semester courses, for courses with less than five recitations per week, and for courses in subjects not requiring preparation, a proportionate amount of credit is given.

The following limitations have been fixt in determining the amount of credit given:

1. Pupils who receive extra credit may not take work in excess of 4 units on a basis of C (75) grade, physical training excepted.

2. Pupils may take a maximum of $4^1/_2$ units reckoned on a basis of C (75) grade in case the excess over 4 units is for subjects in Group VI or debating, dramatics, or music. But no extra credit may be received for high grades.

3. Pupils taking work in excess of 4 units on a basis of C (75) grade will receive penalty for low grades.

4. Pupils will be allowed to take work in excess of $4^1/_2$ units on a basis of C (75) grade only when the average grade of the previous semester has been B, except by special vote of the faculty.

5. The total excess credit shall not be more than double the amount earned in the last half of the course.

This plan is devised to meet two distinct aims. It aims first to offer a substantial reward, open on equal terms to all, for work of a quality above what has been found in practise to be the median standard of the school, as well as a corresponding penalty for work falling below this standard. It will be noted that for work of exceptionally high grade a pupil taking four subjects may secure credit for 5 units in one year. With the one unit in physical training and hygiene, required of all, which it will be noted in limitation 1 may be taken in addition to the four subjects, such a pupil may complete the requirements for graduation in three years. It should be carefully observed that for graduation such a pupil must have completed two major sequences of three units each in two groups and two minor

sequences of two units each in two other groups, beside the minimum of one unit each in the two remaining groups. Such a course, completed with a very high degree of excellence, meeting the important demands of breadth and sequence, can be defended from every reasonable standpoint.

The other aim has been to limit the growing tendency to take an excessive number of courses which has greatly lowered the efficiency of high school classroom achievement in respect to both quantity and quality of work accomplished. It is doubtless possible and desirable for some pupils to accomplish more than the normal amount of work. The foregoing plan makes this a privilege to be secured as one of the tangible rewards of excellence in previous work. Limitation 4 provides for exceptions to the number of courses allowed a pupil. Only one pupil last year was allowed to exceed this limit by special vote of the faculty.

The plan of varying credits is not confined to high schools but is found also in several of the higher institutions. Both Columbia and the University of Missouri have employed the system for several years. The plan at Columbia, as reported by one of the administrative officers is as follows: "Any student who receives no grade lower than B in any half year receives one point of extra credit for every two A's up to a maximum of three points for extra credit. No student may receive points toward his degree for more than one course in any half year in which he receives a grade of D."

The Missouri system of marking is different from the ordinary system in that students are always given relative marks. Approximately 50 per cent of the students in all classes receive the mark M, which means mediocre. Above and below this group are groups comprising 25 per cent who on the one hand are the excellent students, and on the other hand are the inferior students. The following statement of the plan is made by President Hill: "Students who belong to the 50 per cent medium (M) class get normal credits; those who make the grade of superior (S) get 15 per cent additional credit; those who make the grade

excellent (E) get 30 per cent additional, while those who make the grade inferior (I) get only 85 per cent of the normal credit; those who are so poor as to get failure (F) receive no credit at all."

The University of Chicago, in its system of grade points, employs a modified form of this plan, assigning a certain number of points varying from 6 for the highest grade to —4 for failure and requiring a total of 72 points before granting a degree. This system differs from those described in that there is no reduction of the number of courses required for a degree as a reward for work of high quality.

As regards the results secured by this method of granting varying credit, there is not as yet sufficient specific material to justify any certain conclusions. The experience of Columbia has been that more students are influenced by the penalty than by the excess credit. No exact figures are available to show how far the excess credit has actually been awarded to students, but that part of the system in that institution is regarded of relatively less importance than the penalty for lower standing. At Missouri, where the system has been employed for seven years, Professor Max Meyer gives the following facts regarding the number of semesters required to secure graduation over a period of three years: Six per cent graduated after seven semesters; fifty-eight per cent after the normal period of eight semesters; thirty-six per cent graduated after nine or more semesters. It appears that at Missouri also the penalty is the more impressive part of the system, although a considerable number of students are influenced and profit by the reward for superior attainment. In interpreting these percentages it should be borne in mind that under any system there are some students who require more than the normal time to complete the course.

In the high schools mentioned as employing this system, there is also lacking any body of material to justify certain conclusions. It is the judgment of the faculties in each school that it has stimulated a greater interest in scholar-

ship among the pupils. In the University High School during the five years since the adoption of the system no one has by reason of this system secured graduation in three years; a few have been graduated in three and one-half years. A considerable number have secured in four years a substantial excess above the number of units required for graduation. Up to the beginning of the last year there were no limitations as to the number of courses allowed. For this reason, pupils were able to make up for the penalties attending low grades by taking additional work, so that no one has failed of graduation expressly because of these penalties. This year there are several pupils who seem likely to fail of graduation because of the diminished credit which they will receive. In the case of some of these there is clear indication of an increase of serious effort which may serve to relieve them from the impending disaster.

A study of the grades given in the University High School shows that there has been a gradual increase in the number of pupils receiving high grades since this system of assigning credit has been employed. This in itself would not prove that the number of pupils doing superior work has increased for it might be that teachers have been giving higher grades for work of the same quality. The conclusion may fairly be drawn that the quality of the work has been improved from the fact that the quality of the work of graduates of the school on entering college has shown a corresponding improvement. As ninety per cent of the graduates enter college this improvement is significant. The thirty-eight students who entered the University of Chicago in 1915 secured the highest average grade during the first quarter ever secured by any class graduated from the school.

There might seem to be valid objection to this plan on the ground that the higher institutions to which our pupils go do not recognize credit secured in excess of the normal amount of one unit per course. But with the growing recognition of the unity of the work of the upper years of

the high school and the earlier years of the college, it seems certain that we shall soon have an opportunity to make still more tangible the rewards for excellence of work, as well as to test the validity of this new practise, at least from the standpoint of efficiency. The University of Chicago is now making an experimental test by admitting pupils from a few schools on this basis of credit. Few, if any, will doubt that a pupil with less than the normal number of units for work of high grade is as competent to do college work as another pupil with a considerably larger number of units secured at the lowest passing grade. Graduates of the University High School will soon present claims for advanced standing at the university on the basis of units secured in excess of those usually given for the same number of courses. We shall wait, with interest, to see if their college records justify this action. While college records do not offer the only, or, perhaps, the best, test of school practise, it is fair to assume that efficient habits of work and a desire for high achievement provide an excellent basis for success anywhere.

A more serious objection to the plan is found in the variation in the methods of grading of different teachers. A study of the grades given by all the teachers in any school is likely to reveal very great differences in the percentages of high and low grades given by different teachers. It would seem that the amount of credit a pupil receives under the system of varying credit would depend largely upon chance if pupils are arbitrarily assigned to classes, or upon their skill in making a favorable selection if pupils are allowed to make their own schedules. If any plan of varying credit is to be employed it is necessary that the system of grading shall be so standardized that it may be reasonably certain that a grade of 90 secured in mathematics shall represent the same degree of effort and accomplishment as is represented by a similar grade in history or any other subject. In the University High School, the grades are tabulated each year, and any teacher whose distribution of grades differs materially from the normal

distribution of the entire faculty is expected to justify this variation on valid grounds. It is possible for any school to secure such uniformity in grading as will assure a just award of excess credit for high grades or penalty for low grades.

In a recent number of the *School review*,[1] Professor Ruediger has criticized the system of varying credit on the ground that quantity and quality are quite different things which can not be logically interchanged. "Two students," he says, "who have completed the same course in physics, one with a grade of A and the other with C, may have a knowledge of precisely the same things, the difference lying entirely in the grasp upon this knowledge." Grasp upon this knowledge, he evidently regards as a qualitative fact in distinction from the knowledge itself which he regards as a quantitative fact. A person's grasp upon knowledge can be tested only by his power to apply this knowledge which is quite as capable of quantitative test as any other product of school work. The fact is that variations in school grades, if properly assigned, represent corresponding differences in quantity as well as quality.

Professor Ruediger also objects to the plan on the ground that it introduces a vicious artificial incentive. Granted that grades are to be given in some form, it may be urged that grades varying according to quality are less artificial than under the system usually employed. In most schools certain distinctions are awarded for grades on a competitive basis. Rewards of the tangible sort provided by the varying credit system, open to all on even terms, place distinctions for scholarship on a much higher social plane. There is no distinction between the winner and the loser, but each may win the same amount as any other.

It is a very artificial situation indeed which leads pupils to conclude that there are no degrees of success and failure. Commenting upon the experience at the University of Missouri, Professor Meyer makes this significant statement:

[1] Is Credit for Quality Sound? by W. C. Ruediger, *School review*, Vol. XXIII, p. 450–454.

"As to the poor students, I think that our system impresses them with a proper estimate of their individual value in human society as nothing else could impress them. It thus saves them the tragical disappointment of later life. If a college education is a preparation for life, then it would certainly be wrong to nourish in the students the illusion that there is in life only absolute success and absolute failure with nothing between."

The impressive fact of the marked differences shown by individuals is the background for some of our most significant changes in school procedure. The widespread interest in teaching pupils how to study gets its impetus here. Our efforts have been and still are mainly directed toward increasing the efficiency of the lower third of the pupils in our classes. But good school practise, while improving the work of the less able or efficient, can not neglect those of superior ability. Any teacher, who stops to analyze the situation, realizes the tendency to allow the more brilliant pupils to be satisfied with a lower grade of work than they are capable of. That these pupils should learn good habits of work and should be satisfied only with the best possible attainment, is more important, even in a democracy, than that a few more of the dull or lazy should escape failure. The system of varying credit furnishes helpful incentive to the abler pupils to acquire good habits of work and will help to make smaller the number of students of that type who in college are satisfied with the gentleman's grade.

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V

THE MANNHEIM SYSTEM OF SCHOOL ORGANIZATION

A unique system of school organization was adopted in Mannheim, a city of 200,000 inhabitants in the Grandduchy of Baden, in 1901, a system which ever since has been the subject of most animated discussion in the educational papers and teachers' meetings not only in Germany but in all the leading countries of Europe. This plan of organization, a wide departure from the plans followed in all other cities of Germany, is based upon the following principles:

Children of the same age do not present the same type of mentality, the same degree of ability to do the ordinary school work. There is a great variety in their physical and mental make-up.

There is the child of normal mental capacity to whose power of grasp the course of learning is generally adjusted. There is the abnormal or defective child who is constitutionally incapacitated to do the work assigned to the elementary school and who must, therefore, receive different educational and instructional treatment.

But between these two there is another type, the slow, dull and backward child who can master the subjects of the school curriculum, but can not master them in the time which is sufficient for the brighter normal child. It is this type that needs more individual attention and more help than the teacher in a room attended by 50 or more children can give it, the child that always lags behind, becomes discouraged and diffident, the child whom the teacher is tempted to recommend for transfer to the classes for defective children because he hinders him from accomplishing what the school requires with the brighter children. There is still another type, the exceptionally bright and ambitious child who can

do more work than the course of study requires and desires to do it.

In 1901, 36 per cent of the pupils of Mannheim who became 14 years old and left the schools had finished the 8th grade, 39 per cent the 7th, and 25 per cent the 5th and 6th grades. This would seem to us with our experience a rather favorable condition. But the superintendent in Mannheim, Dr. Sickinger, asks: "Why should so many boys and girls leave the schools with an unfinished preparation for the duties of life? How can we reorganize our school system so as to do justice to all, to give the child the best that with his mental capacity each can acquire and to give each child an education which, in some measure, is finished and complete?" This, he decided, can be done only by adapting the school work to the mental ability of all and, to that end, different courses of study must be shaped for the different types of children.

In explaining his system to me, Dr. Sickinger said: "School work must be properly adapted to the mental ability of the child. Work not correctly fitted to the child's capacity leads either to overtaxing or crippling his powers. The same education for all is a maxim which will not hold good. Not the same course of training for all, but the same possibilities for all to receive the best education which the natural ability of the child will permit. The mental power of from 5000 to 10,000 children who enter the schools in large cities year after year varies between 100 per cent and 20 per cent. To expect all these heterogeneous elements to do the same work in the schoolroom is, in many cases, the same as to expect a child to carry a load that requires the shoulders of a man. If everybody can not carry the same weight and still everybody's power to carry is to be developed to its full extent as a rational education requires, then why not differentiate within the masses, as nature and practical life do, and give everybody as much to carry as his powers permit? We have, in all large elementary schools, parallel classes of the same grade and quarter. Why not put the weaker together and give them

a different course of study adapted to their power of grasp? We have opened classes for the small per cent of defective children. Have we a right to deprive the much larger per cent of slow children of an education adapted to their needs?" "Such thoughts," Dr. Sickinger concluded, "led me to give the city of Mannheim a new system of classification."

In 1901 all children who found it difficult to keep up with the brighter classmates were assigned to special classes. The maximum number of pupils in such a class was to be 30, and the classes were placed in charge of teachers who seemed to be specially fitted to take care of this type of children. The course of study was so shaped as to omit features too difficult for the grasp of these pupils and to contain work that would arouse their interest and call forth their self-activity, manual work, outdoor observation work, school gardening, and such subjects.

When new pupils 6 years old enter the schools of the city, they are placed in one of the lowest rooms for normal children. If any of them are found defective, they are transferred to the classes for defective children. If, in the course of the first year of the normal classes, children show that they are slow and backward and can not do the work of the grade in a year, they are, at the close of the first year, placed in the special classes for slow children, *Foerderklassen*. The children in these classes have seven years of elementary school life left, and to them seven years' work that they will be able to do and to do well, is assigned. Any of these pupils may be retransferred to the normal classes when, as a result of the individual instruction and the work better suited to the ability they have shown, there is evidence that they may be able to keep step with the children of average ability. Slow pupils coming from schools in the country or in other cities are placed in the *Foerderklassen* which correspond with their capacity and attainments.

Some pupils in the special classes, however, are slower than others and some of these do not finish the 7 grades in 7 years. Dr. Sickinger insists that every child leaving

the elementary school shall have acquired a training which is, in some measure, complete; in other words, that he take with him as much of the things taught as, under all circumstances, he should have, to be in some measure prepared for the duties of life. To accomplish this, *Abschlussklassen* (finishing classes) are established for pupils who, when reaching the 5th or 6th grade, have become 13 years old. During the last year of their school curriculum a modified course of study in the *Abschlussklasse* attempts to give them the essentials of the things they should learn before leaving school. For the unusually bright children, the so-called *Sprachklassen* (language classes) are opened. All pupils who, when they have finished the 4th grade, show that they can and will take up more work than is prescribed by the course of study, are placed in the 5th grade (preparatory language class) where, in addition to the other subjects, they receive instruction in French. If they succeed in holding their own in this class they go on with their course in the language classes and pursue a four years' course in French. If they fail, they are retransferred to the normal classes.

Children who are to enter the secondary schools leave the normal classes at the end of the 4th year. Such children are placed in the preparatory high school classes at the beginning of the 3rd year. The course of study for these classes is so shaped as to give the pupils a better preparation for their work in the secondary schools. It goes without saying that a complete division of normal, exceptionally bright, slow and defective children with a sufficient number for each room can not be made in one schoolhouse. The city is, therefore, divided into sections, and one of the four or five schoolhouses in each section is assigned to the pupils who have been taken out of the regular rooms because they need more time for their school work. The classes for defective children are generally placed in another schoolhouse, but in some cases find room in the schoolhouses for slow children. The other buildings in the district are occupied by normal and unusually bright children.

I was in Mannheim four days and visited *Sprachklassen, Hauptklassen, Foerderklassen and Hildsklassen,* and I must say that I saw good work in all classes. Of course, I gave more time to the classes for the slower children. I was particularly interested in what these children were, what they learned, and how they learned it. That most of them were not as quick and alert as the average child was quite evident. But they did their work well, were deeply interested and found pleasure in it. This was due to the fact that all the work was adapted to their power of grasp and that they had as teachers men and women of forceful, impressive personality, whose fine influence they simply could not resist. I found quite a few pupils who reacted so readily that I should hesitate to pronounce them mentally slow. I questioned the principal concerning these and he told me that they had been unable to do their work in the regular rooms, but had become wide awake under the different conditions and influences.

In 1901, 36 per cent of all the pupils leaving the Mannheim schools had finished the 8th grade, as was stated before, 39 per cent the 7th, and 25 per cent the 5th and 6th. According to the report for 1911–12, 64 per cent left the highest grade of normal and *Foerderklassen* in July of this year, 26 per cent the 7th, $8^1/_2$ per cent the 6th and $1^1/_2$ per cent the 5th grade. If we consider, the report says, that 20 per cent of the pupils having entered the schools 8 years ago—and they are included—had left the elementary schools to go to the secondary schools and that quite a number of pupils had moved to other cities and had been replaced by such as had come from schools differently organized, the result is certainly very favorable.

The Mannheim system has been in the public eye ever since it was inaugurated, not only in Germany, but in all the leading countries of Europe. In every place to which I came, the Mannheim school organization was discust. Every large city in Germany and some in other countries have sent delegations of teachers to Mannheim to study the plan. Many cities have adopted the plan in a modified way,

i. e., by opening a number of *Foerderklassen* in the same building in which the children go to school or by establishing the finishing classes for retarded pupils.

Some of the larger places that have opened classes for slower pupils are Vienna, Leipsic, Charlottenburg, Copenhagen, Basel, Bonn and Chemnitz. Among those that have organized *Abschlussklassen* in addition to the places mentioned are Bremen, Zurich, Stuttgart, Darmstadt and others.

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VI

AIM IN EDUCATION

The education of the school is from one point of view plainly a process of development resulting from experience. As school experience differs in no essential respect from experience gained outside the school, so far at least as its effects are concerned, the entire development of a child, or of an adult, or even of a social group for that matter, may be regarded as an educational process, as indeed it is. This process is both natural and artificial; that is to say, it is the result, in the first place, of the operation of unconscious natural forces, of experiences which, however conscious and purposeful, are not entered upon with any thought of their educational value; and, in the second place, of experiences expressly designed to exert an educational influence. Much of the education of a child, still more the development of an adult, and most of all the progress of a social group, say a nation, is wholly natural, an incidental result of activities put forth with no thought of the educational influences these activities will exert upon the agent. Such activities bear to natural or incidental education about the same relation that activities connected with obtaining food and consuming it bear to nutrition and the development of the body. We eat for the satisfaction it gives us; assimilation and growth are incidental results.

When we thus extend our conception of the educational process to include the entire development of the individual and of the race, we see that in point of time natural education antedates artificial education and includes by far the larger part of individual and race experience. To deal adequately, then, with the present subject will require attention, first of all, to the question of aim in natural educa-

tion. We may begin by considering the aim of nature in general.

In the field of inorganic nature there is a tendency in all movements and processes to a condition of stable equilibrium, that is to say, to a balance of nature's forces and a resulting cessation of motion. It is easy to see why this is the case. If there were only one force in operation there would be no such tendency. The first law of motion asserts that a body once set in motion will move forever in a straight line unless acted upon by some other force. But in inorganic nature all bodies are thus acted upon. Everywhere there are conflicting forces, centripetal and centrifugal, gravitant and radiant, and one force constantly tends to neutralize an opposing force and thus to bring the body acted upon to a state of rest. Hence it is universally true in this field of phenomena that a body in motion tends toward a position in which the forces acting upon it will be in a state of equilibrium. Equilibrium or a balance of nature's forces, then, is the end in inorganic nature and in all its operations. Is there in these operations also an aim?

If in this realm we isolate a single phenomenon, say, for instance, the flow of a liquid falling on an uneven surface and settling into a depression, no one, I suppose, would assert that there is a conscious aim in the process. Water, we say, "seeks its level," but it does not aim to do so; it is merely passively obedient to nature's forces. Clouds sweep over the land, rain falls, rivulets and rivers follow their courses, but the cloud does not aim to shed rain in a particular locality nor does the water aim to reach the sea. A rock loosened on a hillside rolls to the bottom, pursuing a course dependent upon the character of the surface over which it moves; it strikes various objects in its path; but we do not attribute to the rock an aim to follow just that course, to strike the particular objects which it does strike and to stop at a particular place. All that happens is, first, a disturbance of the balance of nature's forces operating upon the rock and, second, movement of the rock until this balance is restored. Its course and final position are wholly accidental.

Thus we might take any other phenomenon of inorganic nature and find it equally devoid of aim. If there is no aim in such phenomena when taken separately, there can be none if they are considered in the mass. The simple fact is, as has already been said, that in inorganic nature there is everywhere a tendency of objects to stable equilibrium and a cessation of motion when this equilibrium is established. It is a chance world in the only sense in which the word chance is scientifically applicable, namely, in the sense of unintended action. If we balance a stick on the sharp edge of a knife and set it in motion by applying an impulse at either end it continues to move until equilibrium is restored, but the stick does not aim or intend to come to rest in a horizontal position. Such position is merely the end at which its motion naturally ceases.

The foregoing illustrations sufficiently indicate the fact that inorganic nature is a great domain of unconscious forces operating upon the world of material objects with no more aim than may be attributed to the ocean as it hurls its waves upon the shore and tosses the ship upon its bosom. There are ends but no aim. These ends may all be exprest as balance of forces, or "adjustment."

Passing now to the field of organic nature we find that the same thing is true of organic phenomena. The tendency always and everywhere is toward the adaptation of the organism, or of the species, to its environment. This tendency, as in inorganic nature, is the result of the operation of unequal forces. The principle is the same. Adaptation is only another word for adjustment. It is brought about in the same way, that is, by the operation of conflicting forces, internal and external. A tree grows, for instance, until it reaches a certain size or height. Why does it not continue to grow until it pierces the clouds? Merely because a point is reached in its development at which the forces pushing it upward are counterbalanced by those operating in the contrary direction. Its size is limited because, in biological language, the anabolic and katabolic forces reach at last and for a certain period a state of equi-

librium. No one would contend that the tree aims to grow to just such a size or height. Again, a seed germinates, the plant appears, blossoms, develops its fruit and its seed and then dies. All this takes place merely in obedience to natural forces operating upon and within the plant, there being no more intelligence or aim in the process than in the cases already cited with respect to the water and the cloud. The whole evolutionary process of an organism, or of a species of organism, takes place in the same manner, that is, thru development in the direction of the adjustment or balance of the forces involved in the process. There is an end but no aim, the end being the adaptation of the organism or the species to its environment, which is only another expression for a balance of nature's forces.

The truth of what has just been said may, perhaps, be best illustrated by what takes place when the numerical relation of the different species inhabiting a particular locality is in any way disturbed. There is, as has often been remarked, a delicate adjustment of the different kinds of organisms inhabiting any given region. This adjustment may remain stable or comparatively so thru a long period of time, thus giving a uniform appearance to the face of nature. But it is easily disturbed, thrown out of balance, and there is no telling, without more knowledge than we usually possess, what the effects, immediate and remote, will be from the slightest disturbance of this adjustment. When salmon on the north Pacific coast are scarce, otters are said to take to the land and live upon the eggs of birds. The effect this will have upon the birds and upon the insects which they devour is only the beginning of a series of effects which it would be difficult or impossible to trace thru all their ramifications. English sparrows were brought to Philadelphia in the expectation that they would devour the "measuring worms" which dropt from the trees upon the people passing below. Altho the sparrow is not primarily a worm eater, he did so far succeed in disturbing the equilibrium of organic life in that locality that the tussock moth increased to such an extent that its caterpillars de-

foliated and almost destroyed the valuable shade trees which had formerly served as the home of the objectionable worms. Darwin's illustration of the curious and complex relations existing between certain forms of plant and animal life in England may be adduced, altho it is doubtless familiar to all. "Humble bees alone," he says, "visit red clover as other bees can not reach the nectar..... Hence we may infer as highly probable that, if the whole genus of humble bees became extinct or very rare in England the heartsease and red clover in England would become very rare or wholly disappear. The number of humble bees in any district depends wholly upon the number of field mice which destroy their nests;..... now the number of mice is largely dependent as everyone knows on the number of cats;..... hence it is quite credible that the presence of a feline animal in a district might determine, thru the intervention first of mice and then of bees, the frequency of certain flowers in that district!"[1] Thus we see that an increase or a decrease of any species of animal or plant will inevitably set up changes in other species, and these changes will continue until an equilibrium is restored. It is exactly the same in principle as what takes place when a pebble drops into a pool, but in the one case as in the other nature is absolutely indifferent as to when and where or under what general conditions the balance, adjustment or adaptation is reached. There is no aim in the one process or in the other.

We conclude, then, that as there is no aim in inorganic or in organic phenomena there is no aim in nature. This truth may be repugnant to those who have not had occasion to discriminate between nature and art, between the phenomena of nature and the phenomenon of mind. Some will maintain that while there is no aim in nature itself, there is a supervising Intelligence which directs all natural phenomena toward the realization of some distant end. This may be true. It may be, as Tennyson says, that there is some "far off Divine event towards which the whole creation moves;" or, as Hobbes exprest it, that "nature is the

[1] Darwin, *Origin of species*, 6th ed., New York, p. 68–69.

art whereby God governs the world." The two views are not mutually exclusive. But this is a matter with which we are not immediately concerned. It is enough for our purpose if we have succeeded in showing that in the natural processes of the inorganic and the organic worlds, there are no aims, only ends. Present knowledge of the forces involved in some of these processes enables us to foresee and predict these ends with unfailing accuracy. Greater knowledge will make it possible to anticipate more of them, and to change them by the ingenious manipulation of nature's forces. It is because this is true that we are able in proportion to our knowledge to control nature and, by invention, cultivation, education and legislation, to direct all her processes into channels of human advantage. On no other basis could we hope to realize the conquest of nature.

From what has been said it follows, of course, that there is absolutely no aim in natural education. In all the undirected experiences of the child, the adult, or the nation, there is absolute indifference on the part of nature with respect to the effects or results of such experiences. They may be progressive or regressive or they may nullify the effects of one another; it is all one to nature.

The recognition of this truth will destroy that easy optimism which holds that somehow or other nature will take care of children and of nations who can not or do not take care of themselves or in whose interest nobody works with a conscious aim. There is a famous painting representing a child crossing a stream on a foot-bridge. The handrail is broken and the child seems likely to stumble and fall into the water, but over the child hovers an angel to guide and guard its footsteps. The picture is entitled, The Guardian Angel. The obvious implication is that Providence will take care of the innocent child even if there has been the grossest carelessness with respect to its safety. But if the child stumbles and loses its balance, it will surely fall, just as any other object heavier than air would fall under such circumstances. The day of miracles is past.

If you would save the child you must fix the bridge, or make it inaccessible to children. This view of the situation, and this view alone, will awaken in the parent, the teacher and the community a full sense of their responsibility.

The general acceptance of this philosophy of the indifference of nature would put an end not only to the pious talk about the care of nature for children, but also to the equally vain assertions of a "Divinity that shapes our ends, rough hew them how we will," and of the inevitable glorious destiny of a people independent of their own aims and efforts. The only destiny which nature holds for child, man or nation is adaptation to circumstances, and this adaptation may mean regressive or progressive development, advance or decline, life or death. If we would have continuous progress, individual or national, we must formulate lofty aims and put forth intelligent effort to control circumstances so as to assure adjustment at higher and higher levels. To be sure, unassisted nature may achieve progress; but then, again, it may not.

Having seen that there is no aim whatever in that part of the educational process carried on by nature, we turn now to artificial education, that is, to the education in which intelligence plays a part, formal education in the widest sense.

Education in the formal sense had an apparent beginning in the instinctive action of the lower animals. The hen, the falcon, the robin and other birds appear to teach their young. The bear is said to educate its cubs. All this, however, is probably instinctive and is to be accounted for in the same way as other instincts are accounted for. Such education has no conscious aim and belongs really in the realm of natural education.

The true beginning of artificial education must probably be ascribed to the primitive human mother. Her maternal affection naturally led her to try to shield her offspring from the effects of experiences perceived by her to be harmful to the young and to encourage those forms of activity which she had learned were safe. This necessarily involved

discipline and more or less instruction, that is, education with a conscious aim. The mother, then, in all probability was the first teacher, and the teaching process at the beginning proceeded from a less selfish basis than it has in most of the institutional education that has since been carried on.

In the course of time the particular value of certain kinds of knowledge was perceived by certain members of the social group, and education became the business of those who assumed to possess this knowledge. These early educators were the medicine men. The medicine man, or mystery man, as he is sometimes called, later became the priest, and for thousands of years the education of the youth was chiefly in the hands of the priestly class. The object of instruction at this time is thus exprest by Spencer: "Tho during early years each youth gathers, in miscellaneous ways, much which is properly to be called knowledge, and which serves him for guidance in ordinary life, yet there is a kind of knowledge, or supposed knowledge, particularly precious, which does not come to him thru the irregular channels of daily experience. Equally in savage tribes and among early civilized peoples, ghosts and gods are believed to be everywhere and always influencing men's lives for good or evil; and hence, of chief importance is information concerning the ways in which conduct may be so regulated as to obtain their favors and avoid their vengeance."[2] To impart this information was the aim of education in this far-off primitive time.

Instruction was doubtless limited at first to those who were to become medicine men or priests, but in course of time it was extended, at least in part, to all the young men on their arrival at a certain age. Many savage tribes have today an initiation ceremony by which young men are admitted by the tribe into full fellowship, so to speak, and this ceremony involves a certain amount of instruction.

Aside, then, from such education as the mother may have given, the aim at the beginning of artificial education was

[2] Spencer, *Principles of sociology*, Vol. III, p. 274.

the aim of the medicine man. It was just as intelligent as he was intelligent, and had as little relation to the well-being either of the individual or of the social group as his own thought and purposes had to these unselfish ends. Education consisted chiefly in the impartation of supposed knowledge of what were regarded as sacred things and in clothing the youth with the benefits which this knowledge was supposed to bring; it was not yet institutionalized.

When an authority superior to the medicine man arose in a tribe, we may be assured that primitive selfishness and regard for his own interests led such authority to pay attention to the education of the youth as a means of promoting his own personal aspirations for himself and his tribe. The aim of education was made to coincide with his own aim, in so far at least as education was likely to affect his privileges, condition and aspirations, including, of course, the welfare of the group as he conceived it and desired it. The same thing was true when the dominant authority became a class instead of an individual. Common interests and a sense of class solidarity led to the more or less conscious perception of a class aim, an aim not necessarily in conflict with the well-being of the social group but proceeding primarily from considerations of class interests and class privileges. Education thus became primarily a means of promoting such interests and has remained so, in large part, to this day. There is no country in the world in which education is entirely free from the influence, direct or indirect, of the class in power; or in which the aim in education is not to some extent a class aim. There is always insistence that education be safe and sane, and both its soundness and sanity are questioned unless it serves the ruling classes or, at the least, does not threaten with too much severity the privileges which that class enjoys. In times of slavery, for instance, only such education was permitted the slave as taught him to keep his place and tended to make him more efficient in it, that is, more servile. Similarly the education of the lower classes must not fail to inculcate respect for authority, the powers

that be. Why is it that in Europe today so many of the laboring classes are in the trenches, altho the laboring classes least of all can hope to profit by the war? It is because the laborer has been taught that the aim of his betters is the true national aim of his country. He has been given a sound education—sound when, socially considered, it was not fury, signifying nothing.

We may formulate a truth, then, which is in the nature of a law. It is this: the aim in education is always a reflection of the general purposes of the dominant class in a social group. As I have elsewhere said: "Education, whatever else it may be, has always been the attempt on the part of an external authority to develop individual personalities in the direction of a preconceived good. What this 'good' is must always find its explanation in terms of the educating power. I apprehend that no one will have any difficulty in perceiving that it can not be the same when education is by the church that it is when it is by a state indifferent to religion. It is not likely to be the same in a despotism as in a democracy."[3]

This does not mean, of course, that the aim in education thruout history has been entirely anti-social. The aims of individuals and of classes must have a social content in order to persist for a period long enough to affect in any great degree an institution like the school. It means only that the aim in education will always reflect the thoughts, purposes and wishes of the dominant class and that, for this reason, the actual aim in education is dependent upon the structure and organization of the social group.

They are in error, then, who declare that the school is or ever has been generally and primarily for the child. Men in general are not so unselfish as all that. The school is historically and now an institution established in the interest of those who establish it. Those who are responsible for it would never provide for or support it if they expected no benefits from it, or if they believed the school to be inimical to their privileges and interests. They will

[3] *The fifth yearbook of the National Herbart Society*, p. 94–96.

permit and encourage education only so far as its aim is consistent with the maintenance of their privileges and, when possible, they will employ the school to bolster up their privileges and to promote their doctrines and ideals. Witness the fly in the ointment with respect to some of the present agitation for industrial and vocational education, and for military training in the public schools.

We may talk all we like, then, about the ideal aims of education—character, self-realization, harmonious development, social efficiency, and the like; it is a harmless kind of speculation. But when we come to interpret these aims, and give them a definite, entire and unbiased social content, we invite the suspicion and are likely to awaken the hostility of the solidest and most substantial elements of the community. Hence the socialization of the school will be incomplete until all classes in society are eliminated and society truly governs itself, formulates its own aim and seeks intelligently to realize it. Education being the obvious and most effective means for that purpose nothing will then prevent it from becoming truly social. Even then, however, it will be subject to constant correction. When society becomes conscious enough and intelligent enough to have a definite aim of its own, such aim can not be other than some real or supposed form of social well-being. Whether it will really coincide with ideal social well-being will depend upon the capacity of society to perceive in what direction its true interests lie, and its ability to hold constantly and steadily to such interests as a conscious aim. This will depend, of course, upon the general possession of scientific knowledge of the potentialities of society and the social recognition of the most effective means of realizing these potentialities. This knowledge must await the advance of a true science of society, and the general distribution of its proved results. It is the function of this science to formulate upon the basis of existing social conditions and possibilities the true and ultimate aim of society which, of course, is the ultimate aim in education.

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VII

SCIENCE AND THE AGE OF THINGS

"The interests of grade children are principally in things, while the dominant interests of high school pupils are social."—J. H. McCLELLAN.[1]

Any man who past thru a real boyhood has only to think back a little to recall a time when he seemed to live in a serious and engrossing world very sharply separated from the world of adults, when his soul had not yet received its earthly freight and custom did not hang upon him with a weight, heavy as frost and deep almost as life itself. In that period usually comprehended by the later grades and the earlier high school years, the boy belongs to an almost independent social stratum. Adults are tolerated as necessary cogs, as providers, as uninspired chore-performers; mother's beloved son pays little attention to her; home is a place to eat and sleep and to be otherwise ignored; girls are out of the question; the minister a theorist talking an unknown language; social life reduced to the loose bond of the gang. And yet the boy is always extremely busy, and about what? About things. It is the age of things. It is bats and balls, goals and runs. He is making boats, canoes and engines. It is a pleasure to see the wheels go round in anything. A couple of weeks with an automobile and he is a chauffeur. He looks in at the machine shop; he hangs around the railroad station to watch the telegrapher and to see the trains come in; he experiments with aeroplanes, batteries, telephones and the wireless. As a physical and mental machine he has a roundness of development that he has never known before, and may never know again.

The psychologist has not failed to note this stage. He says, "The child now acquires a life of his own outside of the home circle; his interest will never again be so inde-

[1] Physics in the Grades, *School, science and mathematics*, 1914, p. 507.

pendent of adult influences. The senses are very acute. There is great immunity to exposure, danger and temptation. Reason, true morality, religion, sympathy, love and esthetic enjoyment are but little developed. The rules of the adult seem to the youth alien and arbitrary. The mind is keen and alert, reactions are immediate and vigorous. The memory is quick, sure and lasting. Never again will there be such susceptibility to drill and discipline; such plasticity to habit or readiness of adjustment to all new conditions. Now the finer adjustments are made with ease, and manual skill is easily acquired. There is interest in the product of activity, and no longer entirely in the activity for its own sake. Mental action begins to be better controlled, more connected and more commonplace than in childhood." As a boy of twelve he is a utilitarian. Then he branches out and wants to see the whole world for himself. Altho individuality has become more pronounced the boy nevertheless wants to gather in all experience that he may choose therefrom what he needs for his own development. "Perhaps the most significant change is the excessive craving for all kinds of sense experiences. The impulse is to touch life at every point and to expand every faculty."[2]

But tho the psychologist has recognized these things, what evidence is there that the schoolman has? Just where does the science teacher connect up with this insatiable activity? Do we put off physics until the junior year of high school to prevent the preadolescent and pubertal youth from devouring it too greedily? Do we put off chemistry and botany for fear the youthful mind will be glutted with facts? Possibly so, since now the mind stores up facts, seemingly because they are facts. One might think educators have been wary of utilizing natural propensities in pupils.

As a matter of fact, however, educators do not seem to have had time to concern themselves with the psychological side of science teaching. Prof. Charles H. Johnston states in a recent book that "we tend to put our educational

[2] Partridge, *Genetic philosophy of education.*

theory into textbooks on educational psychology, principles of education, general pedagogy, or theory and practise of teaching, and casually refer to the differentiated disciplines within the courses of study themselves."[3] The reason for the very casual reference to science teaching by educational philosophers, is that they do not know enough about science and science teaching to dare to prescribe with any definiteness. Our present science courses were not known when they went to school. On the other hand, those who have been actively engaged in science teaching have been so engrost in mastering the subject matter of their special courses that they have had no time to study scientifically the interesting object always before them, the individual student. Leaving practise aside, one would have to hunt a long while to find any book which takes into consideration all the scientific work an up-to-date school system now offers, any book which discusses with due fullness the school years during which it may best be taught, and applies our present knowledge of the boy mind to the proper arrangement and presentation of its subject matter. As far as the sciences are concerned we have never adopted anything of "the English custom or the German custom of reading whatever of scientific or established pedagogy we have definitely and specifically into the instruction matter we must in any case dispense."[3] Science courses have entered our curriculums very recently and have been placed in the most haphazard fashion. Physics and chemistry, because they were the first to be adopted as standard high school sciences, and because they have received recognition from college authorities, have been put in the later high school years so that they might be fresh in the mind of the student entering college. Physiography, biology, physiology and agriculture, having had no such standing have had to be content with any blank space that appeared in the curriculum.

If such a method, or lack of method, of curriculum building had worked, we might thank the gods that protect

[3] C. H. Johnston, *High school education*, Preface.

women and children and the United States and go on our way rejoicing—but it hasn't worked. A century has now past in which it has been becoming increasingly true that the world "is ruled by physical science, and by business, which in the vast proportions industry and commerce have now attained, is itself the child of physical science;"[4] we have seen a generation or two of agitation for, and experimentation with science courses, and yet the best friends of science in the schools reluctantly acknowledge that proportionally the science courses are not holding their own.

There is only one conclusion for all this. It is high time that our educators began to study science, and that the science teachers began to study pedagogy. "The statistics of progressive school decadence in science show how the laws of psychic growth, altho too subtle for science to see, are too strong for its best endeavors to overcome."[5] We should ask ourselves some such questions as these: At what age should the serious study of science be taken up? During what part of the school course should science be strest? What should be the order in which the subject matter of our science instruction is to be presented? Due consideration of the age of things will lead to the conviction that our science work will undergo a thoro revision, when these questions are correctly answered.

First, science teaching should be seriously begun down in the grades. "You will never solve your problem of science in the secondary school until you have solved the problem of science in the elementary school."[6] Ample time should be allowed this work every day and no one should be able to speak of "the absurdly small average time actually used in science instruction in the elementary schools of the country."[7] European schools, conservative as they are in many matters, are far ahead of us in the time allowance made for science in what would correspond to our upper elementary grades. At this period when the

[4] Bryce, *South America: Observations and impressions*, p. 344.

[5] Hall, *Adolescence*, Vol. II, p. 150.

[6] Judd, *School, science and mathematics*, 1912, p. 95.

[7] Eikenberry, *School review*, 1912, p. 118.

senses are very acute and the memory quick, sure, and lasting, when the motor phases of education demand emphasis, and manual skill is easily acquired, thousands of useful and scientific facts can be stored away in the young mind thru real laboratory work in science and plenty of it. The pupil can perform hundreds of ordinary experiments with the same facility that he displays in shop work. There is no use in waiting until a youth is finishing his high school course to teach him to measure a block of wood, or the diameter of a wire, or determine the specific gravity of a floating body. There is no need of teaching college men how to bend glass tubing and how to make rubber connections, when a grammar school boy will do these things neatly and with great satisfaction to himself. Until now talk about the value of home-made apparatus has been of little significance because the time element has been left out. When real science work is done in the grades, however, the science teacher and the manual training teacher can cooperate in the matter of making apparatus and obtain excellent pedagogical results.

If science men will forget for a while the chaste beauty of mathematical accuracy and fundamental principles, and allow pupils to exercise their five senses upon actual physical phenomena, they will be surprized at the results. If, in this age of things, physical facts are presented to the boy, they will be assimilated and assorted in the young mind in the same natural way that the facts of language were assimilated and arranged at an earlier date. For generations the human race was gathering the facts of science before the great unifying theories of modern science were possible. In the same way, if we give the boy a broad, solid foundation of scientific fact, an interest in the fundamental principles will later appear as a matter of course. The only way to get these facts into the young mind is to use the physical senses in varied laboratory work. "Satisfactory results in this, as in most other branches of study, can be obtained only by having the pupil do something, by providing that most potent means in the acquisition of

knowledge—physical contact with and manipulation of the thing to be studied."[8]

With good scientific work done in the grades the problem of vocational training will be greatly simplified. The school system will no longer be inspired mainly by literary ideals. The city boy will establish points of contact with the commerce and industry of his environment. The country boy will gain an appreciation of the wealth of culture involved in his father's calling, and it will no longer be true that "if the only road for the country boy to fit himself for higher agricultural work led thru the city high school, he would often be led astray, and oftener still would never continue long enough to make a beginning of such training."[9]

On the other hand if practical work is not given early in the school course, we can never have a smoothly working system. Dr. Dunker, reporting to the Royal Industrial Commission of Prussia in 1904,[10] speaks of the number of students who embarrass the gymnasia because their parents want them to have the social and military privileges which attendance at such schools can give. He says, "If they turn out well in later life it is in spite of the school and not because of it. Very often, however, they enter upon life morose natures, without faith in themselves or their calling, without energy, without creative ardor, irritated against the school which failed to reach them. Of the best that the school can give, of the desire for progress, of the yearning for more and higher things, they have not felt a breath; their culture has come to an end, but also for effective manual work they are spoiled." And those who are able to profit by the purely literary work are not merely held back by the presence of large numbers who can not: their own fuller development is checked, many times irretrievably. "The worst gift, perhaps, that an evil genius has made to our age is knowledge without training in efficiency."[11]

[8] Hugo Newman, *Elementary school teacher*, 1905, p. 192.

[9] Catalogue, Washington State College, Pullman.

[10] DeGarmo, *Principles of secondary education*, Vol. I, p. 173.

[11] Pestalozzi.

If this golden age for instilling the facts of science is allowed to pass unused, much will be lost without compensating gain in other fields. I do not think that my own case is in any wise peculiar. If I had to choose over again, I would want to choose the work I am now in, but, nevertheless, it has required much hard work to make up any appreciable part of what I lost at this period of my school life. As a grammar school boy I and my friends had been interested in building houses, running lathes, setting up telegraph lines. We were as familiar with the car shops and factories as with swimming holes and huckleberry fields. Noticing this my parents decided that I should prepare for the Massachusetts Institute of Technology. On entering high school I took the course laid out as a preparation for this school. As I had no difficulty in interesting myself in any line of work that was offered, this course soon led me away from scientific things. It began with Latin and ignored science till the senior year. When physics was then presented I could get up no particular enthusiasm for it or for the college work to which it led. The years during which an interest in science might have been given me had past, and I had reached a stage of development when broad generalizations had siren power, but when the details of a beginner's scientific course were irksome.

As regards the question, "At what age should scientific work be strest?" there is great divergence between the theories of some of our foremost educators and our actual school practise. The conference on science sent to the Committee of Ten "a resolution that one-fourth of the whole high school course ought to be devoted to natural science, their intention doubtless being that each pupil should devote one-quarter of his time to science."[12] Commissioner Claxton tells us that we should work out a form of science teaching which would take one-third of the time of a six years' high school course. On the other hand, the Committee of Ten in Course of Study No. II made provision

[12] Report of the Committee of Ten, p. 39.

for only three years of science at the most, and under an elective system not one-tenth of our high school students take even these three. In no part of any regular school curriculum does science work preponderate, and when it is emphasized, the emphasis comes in the later high school years. As stating general principles applicable to all students, however, these recommendations would be accepted by few students of education. They do not answer our question. There is a time for emphasizing science and there is a time for emphasizing the humanities. Our youth need the best from both, and as both can not take precedence at the same time we must examine the minds of our students to find out when each can be taught most efficiently.

An English master, whose mind is not fettered by consideration for our irrational organization of secondary education, gives a good answer to our question. He says in speaking of the sciences and allied subjects, "This group of subjects should, it seems to me, in the earlier or general stage of education, up to the age of sixteen or so, occupy as large a place in the school time table as the other equally important group of studies dealing with language, literature and the arts."[13] The American science teacher will cry out against having to teach the bulk of his subject matter to boys from eleven to sixteen years of age, and the teacher of history and literature will not be easily satisfied with less than he now has, but a consideration of the child mind will prove that no other arrangement will work. During these years the boy is interested in things. Reason, true morality, religion, sympathy, love and esthetic enjoyment are but little developed. Not much progress can be made with literature because he has not the mental machinery to apprehend it. Drill in foreign languages almost completely satisfies his needs along this line. The history of adult institutions has little meaning to him because his mind has not reached the necessary stage of development. If at this time the factical side of science has its inning,

[13] J. H. Badley in Hodson's *Broad lines in science teaching*, p. 10.

the later period of adolescence may be more freely devoted to much-needed work along social lines. When the pupil "has changed from a self-centered individual, living physically and mentally for himself, to a matured organism, whose life is henceforth to be lived as a service to the race,"[14] it is time for us to teach him the elements of sociology, economics and political science. At this time also we can, without demanding too much exact definition, give him something of the great generalizations of science. The young man is weaving his philosophy of life, and if we have opened up his mind in all directions before this time, we may rest assured that for the time being science has done its part. To attempt to give now the scientific facts that should have been acquired earlier, is to put oneself in the hopeless position of present-day physics and chemistry teachers.

What G. Stanley Hall says argues strongly for the stressing of science during the prepubertal and pubertal years. "The normal boy in the teens is essentially in the popular science age. He wants and needs great wholes, facts in profusion, but few formulae. He would go far to see scores and hundreds of demonstrative experiments made in physics, and would like to repeat them in his own imperfect and perhaps even clumsy way without being bothered by equations. He is often a walking interrogation point about ether, atoms, X-rays, nature of electricity, motors of many kinds, with a native gravity of his mind toward those frontier questions where even the great masters know as little as he. He is in the questioning age, but wants only answers that are vague, brief, but above all suggestive; and in all this he is true to the great law that the development of the individual in any line of culture tends to repeat the history of the race in that field.[15] A corroboration of this is seen in the recent statistics of boys' general reading where the *Scientific American* and *Supplement* lead all the rest.[16]

[14] Partridge, *Genetic philosophy of education*, p. 83.

[15] Hall, *Adolescence*, Vol. II, p. 156.

[16] *Ibid.*, Vol. II, p. 155.

Lastly, what is the order in which the subject matter of our science courses should be presented? The age of things shows clearly that science teaching *muss umkehren.* Professors of education who find it easy to generalize fall an easy prey to the physics specialist who claims that his science requires extremely exact work and a firm grasp of mathematics, and the chemistry professor who thinks that chemical knowledge without a thoro grasp of the principles of ionization is worthless. Physics may be made entirely quantitative, and chemical theory may be very abstract, but these phases of science have as little place in a high school curriculum as philology. Any grammar school boy can make and use a hydraulic press as well as a man; any child beyond the mud-pie stage can profit from mixing chemicals. Put copper and zinc into an electrolyte and you have a battery; put an acid on chalk and carbon dioxide is evolved; this the child can see and do. This at first is all of these experiments he need know, but this much we should let him know, and what is more, this is just what the child wants to know. When we free ourselves from the custom of putting all that we are going to teach of chemistry in one book, and all that we are going to teach of physics in another and trying to teach each of these subjects once for all in nine months, we shall find that most of the material of these subjects can and should be taken up early in our science courses. This is both the logical and the psychological order. E. D. Huntington in writing of first-year science says, "The fundamental facts and theories of science, and not some specialized branch of science, should constitute the subject matter. The sciences that are essentially fundamental are physics and chemistry, since they are employed as tools by all the other sciences. Without a considerable knowledge of the fundamental sciences, the essentials of these other sciences are memorized and not comprehended. Most of the common phenomena of daily life are physical and chemical; common instances are electric appliances, railway trains, water works, light and heat, combustion, oxidation, respiration, decay and fermenta-

tion. Interest in the biological subjects is largely due to their application of chemical and physical principles. For instance, our interest in bacteria is almost wholly due to the chemical effects they produce. And a proper study of the elements of physics and chemistry will naturally lead the pupil's interest into those general biological relations in which our vital interests lie."[17] Dr. Judd reports, "Mr. Findlay's investigation was made in the elementary school. He raised a question that is supposed by many to be answered. That question is, 'what kind of scientific interest do the pupils exhibit in the different grades of the elementary schools?' You can find it written down in all our pedagogical discussions and journals of science, that you should first study animals and plants; that you must progress slowly to the formal sciences of physics and chemistry. Mr. Findlay took three kinds of science material into our elementary school in the ordinary routine of nature study instruction. He took into the class an interesting animal, an interesting plant, and a rough pendulum. He demonstrated these and then let the pupils ask questions about them. Later he asked them to write a description of what they had seen. The only result that I want to point out is that the pendulum did not suffer by comparison with the animal and plant. Why? I think the answer is that this swinging pendulum presented a compact, easily analyzed phenomenon. When you present that sort of thing the pupils like it because they can comprehend it. A child can be baffled by zoological information thrown at him. He can be as much confounded by that as by any mathematical demonstration in physics. You can not begin with that. You have to begin with something that works easily, that works simply."[18]

When summed up, the reasons why the elements of physics and chemistry should have a large place in the first years of serious science instruction are many and weighty. They yield to the factical treatment at an age

[17] *School, science and mathematics*, 1912, p. 667.

[18] Judd, *Ibid.*, 1912, p. 95.

when the mind takes in its nourishment in the form of separate facts. The experiments and demonstrations may be made simple and easily comprehended; they are confined as regards time and space, and there need be no obtrusive fringe of unexplained phenomena. The work may be elaborated so as to add a large measure of the motor element. The pupil can be allowed to build things, make things go, mix things, and see new things evolve. It offers scope for home-made apparatus, telescopes, batteries, showy experiments of the popular science type, for soap making, dyeing, photography. The elements of physics and chemistry offer a maximum of knowledge which is practical in the narrow sense and which is, therefore, suited to this utilitarian age. They offer the kind of scientific knowledge that first attracted the attention of the race, and which, therefore, will be interesting to the young pupil. From the teacher's standpoint they offer the logical foundation upon which the later course may be built, and at an age when many pupils are nearly ready to leave school they link up well with the manual training and pre-vocational courses.

Because they fail to satisfy these requirements the courses which now precede physics and chemistry should follow a more or less thoro grounding in the elements of physics and chemistry. As first year sciences,[19] "botany, zoology, physical geography, physics, and of late agriculture, have all been tried, and usually have proved unsatisfactory. Among the reasons assigned for their failures the following seem the most pertinent: the first two are too specialized and formal and if presented successfully at this point, must be largely handled in an extremely elementary and superficial way." Work with wild flowers and insects is only beginning to appear practical to the average adult. Why, then, should we expect the child to appreciate anything more than the striking facts of botany and zoology? To him a primrose is a primrose.

Interest in things of nature as such he has little of. That is something the primitive man knows little of and the

[19] E. D. Huntington, *School, science and mathematics*, 1912, p. 666.

ordinary boy less. To be philosophical or sentimental about nature is to him disgustingly feminine. Physical geography has become the specialized and technical physiography which precludes its most effective use in the first years. It is too impersonal, it deals in too large wholes and spreads itself over all time and space. The laboratory work is observational and not dynamic. Its utility like that of botany is too diffused and its underlying principles lead to philosophies the pupil has not grown to, and has no appreciation of. "This textbook maker's pet and pedagogues' abomination often has all the defects charged against popular science, without its saving quality of being made by experts, and dilutes and diffuses itself over the whole universe from stars to geology, crops, politics, history, anthropology, manufacture, mining, commerce—fields that geographical societies wot not of."[20] One schoolman says "the unsatisfactory results of high school physiography are, to my thinking, largely due to what is really too advanced a subject taught by persons who understand it imperfectly."[21] Another thinks that with the increase of junior high schools and the introduction into them of a year or two of elementary general science in what is now known as the seventh and eighth grades, we may, in the future, find ourselves in a position to produce good results in the ninth grade without going outside of the strict limits of our subject. This scheme would doubtless be a great improvement on the present arrangement but it would not be ideal. The subject is so complex, it requires such an amount of expensive equipment, it rests so completely upon the other sciences that it ought to be placed in the last year of our public school system where it may act as a unifying science course and would function vocationally in teacher's preparatory courses and as a prerequisite for normal schools. "In many schools, particularly those preparing pupils for college entrance examinations, an advanced type of physical geography, as it is often termed,

[20] Hall, *Adolescence*, Vol. II, p. 151.

[21] *School science*, May, 1915.

has a place in the later years of the course."[22] "Physical geography and physiography differ only in degrees of difficultness. Physiography was recommended for the senior year of the high school by the Committee of Ten. The conception that led to this recommendation was that physiography would serve an important function in correlating the other sciences of the course. The committee realized also that it was a strong study and required some maturity of mind."[23]

"Physics as a differentiated science was too technical for first-year students. The same boy will perform marvels of wireless telegraphy, the understanding of which he has gathered from his juvenile periodicals, but he will gaze stupidly at his science teacher who talks to him of the elementary units of electricity and ultimately fail in his examination. Five years more of normal growth and that same formalized physics will interest him a great deal more than the construction of electrical apparatus."[24] Finally, agriculture, if studied as a science, requires a previous knowledge of the elemental sciences in which the pupil is wholly lacking. With a reasonable foundation in physics, chemistry and biology a thoroly worth-while course in agriculture can be given. At present our high school courses in agriculture are extremely superficial and of questionable value.

When advancing the claims of general science, educators have put forward many arguments. They state that thirty per cent of high school students drop out before the second year and that this thirty per cent should not be allowed to leave school without a real glimpse of the science field. They claim that a general science course makes for better work in the later science courses. They think that after taking such work pupils have a better knowledge of their own capacity and that later they can make wiser selection of electives. All these the schoolman has to take

[22] Monro, *Encyclopedia of education.*

[23] W. J. Sutherland in C. H. Johnson's *High school education*, p. 220.

[24] H. C. Morrison, 13th year book of the National Society for the study of education, p. 13.

into consideration, but unless one other condition is fulfilled, unless in the work recommended on these grounds an adaptation to the psychological stages of the child's development is made, they should have little weight.

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VIII

THE FUTURE OF ENGLISH EDUCATION[1]

MORALS OF THE WAR

I

A correspondent wrote to the *Manchester guardian* a fortnight ago: "If German education is as perfect as some would have us believe, how can we explain the savagery and lawlessness which we have found permeating all ranks of the German armies? If German education produces the people we are fighting, how can any enlightened Englishman write of its excellence?" This puts concisely an argument which will have to be reckoned with in any attempt at social reconstruction in England after the war.

The answer is that no one whose words have weight has ever said that German education is perfect. It has great faults as well as great excellence. It makes good use of all second-grade ability, which in England is far too much of a waste product. But something in the atmosphere of it makes the Germans too ready to obey. How to get more all-round intellectual keenness into English life, without draining off the reserves of energy which are needed to keep up moral pluck and independence of character, is the main question which the Lord Kitchener of English education, whoever he may be, will have to tackle.

Nor is it true that savagery and lawlessness permeate all ranks of the German armies. There is, I admit, a very significant and deep-seated difference between what we and the Germans think honorable in war. The Germans, as we say, are not "sportsmen." But the evidence at present available seems to show that a very large proportion of the unspeakable brutalities which have disgraced the German name in this war have been done to order.

[1] From the Educational Supplement of the London *Times*, Dec. 7, 1915.

They seem to have been due as a rule to a habit of excessive obedience.

The war has proved the enormous power of education over the minds and souls of men. Applied with persistence and pedantic pertinacity, it is the most formidable engine in the modern world for controlling conduct and swaying purpose. England has shrunk from using this power in a masterful way. We have fumbled with it and been frightened of it. Our reasons for not putting the power of education to its full and most effective use have been partly sound and partly stupid. Stupid, in so far as we have failed to realize how powerful a dynamo education may become; sound, in so far as, for fear of its being misapplied by the state, we have deliberately forgone the advantages of using an instrument which can be set to cut deep into moral freedom and into private judgment on fundamental questions of right and wrong. But whatever we may feel about its capital defect—its idol-worship of the state and its subordination of conscience to system and success—German education has high merits. These have been made clearer than ever by the experience of the war. German education has made the nation alert to science. It has made systematic cooperation a habit. It has taught patriotic duty. It has kept a whole people industrious. Combined with military training, it has given them the strength of discipline. It has made profitable use of second-rate intelligence. It has not neglected the mind.

Great Britain, after the war, will find that better education has become one of the most urgent of her necessities. Our social welfare, the effectiveness of our industries, the elasticity of our commerce, and, above all, the future quality of our national life, will depend upon education in a very great degree. No one can predict at present the economic state in which we shall find ourselves after the war. It would, therefore, be premature at this stage to attempt any precise statement of the changes in our educational system which may have to be made. No one knows how much we shall be able to afford. And cost will be a de-

termining factor. We shall have to cut our coat according to our cloth. But it is not too soon to try to see the whole question in perspective, or to analyze the factors which, if it is fitly to serve England, English education must strengthen or preserve.

II

The power of education in a nation's life depends chiefly on five things:

(1) On the support given to it by public opinion, especially by employers of labor and by associations of workers.

(2) On the earnestness of parents in getting for their children the best opportunities of preparation for life.

(3) On the skill and insight of the government (acting thru the central departments of state, or thru local authorities, or thru endowed corporations, or thru representative societies) in organizing, or aiding the organization of, schools and colleges, tests of their work, staffs of competent teachers (including their professional training and the conditions of their appointment, payment, superannuation, and pension), and an elaborate and stimulating variety of other agencies, including libraries, music and art collections for the quickening and cultivating of the imaginative power and critical faculty of the nation.

(4) On the vitality of the intellectual, spiritual, or artistic traditions in the community; and

(5) On the purposeful industry and self-training of young people while receiving education at school or college, and afterwards.

Five things education seeks to train and develop, in each case in a body which, as far as may be, is vigorous thru strict but happy exercise and disciplined to self-control. These are, first and foremost, character, which may be described in the words of the Book of Wisdom as consisting in "soberness and understanding, righteousness and courage;" secondly, a sense of obligation to the community and to the world-wide commonwealth of good men and women; thirdly, the power of concentrating the mind upon the task in hand;

fourthly, a ready memory, including skill in using aids to memory, and quickness in finding sources of accurate information; and, fifthly, open-mindedness to fresh truth, from whatever quarter it may come, and capacity to grasp rapidly the ground plan and bearings of a new subject.

In grappling with this task, education must combine freedom with authority, discipline with stimulus, bold experiment with the tested wisdom of the past. It must be just to the claims of both sexes. It must give full opportunity of advancement to boys and girls of talent and promise, however humbly born or straitened by early circumstance. It must not be so organized (as it may be) as to shut out from high places in the professions, in industry, or in public administration those whose early training may have been scanty, but who have recovered their ground by later study and by the exercise of an alert intelligence upon the lessons of life. It must draw into the service of the schools and colleges teachers of vigorous personality, high purpose and scholarly attainment. Above all, it must hold the moral law sovereign above state authority and self-interest.

III

In modern education, which for the last twenty years has been everywhere in a state of tension and painful hesitating readjustment to the new conditions of thought and life, there are three great representative forces—Germany, the United States, and the British Empire. Each is typical of a different point of view; each contributes a different experience; and each can testify to the amazing power of educational influences when effectively applied. Germany stands for unity based on the state. The United States stands for variety based on the individual. The British Empire stands for an attempt at moral unity, based partly on individual experience, partly on the inherited tradition of various social groups, partly on administrative organization. Germany and America have worked on simpler theories and have had the advantage of greater simplicity of aim. The British is the more complex view, the least

easy to define, and the most liable to ineffective compromise. But the facts themselves are complex. The British tradition at its best seems, to me at least, to have got nearer to the truth than either the German or the American. But British education, when it falls below the best, as is too often the case, is far less effective in accomplishing its aim than are the German and the American in accomplishing theirs.

British education, and especially English education at its best, is stronger than any other in the development of personal character. The same care which the Germans have lavished on ways of securing intellectual attainment, and which the Americans have spent on methods of fusing together the diverse elements in their heterogeneous population, has been given in Britain, and particularly in the best English schools, to questions of personal conduct and character. British education has also been at least as effective as the German or the American in fostering the will to make that supreme sacrifice of life or limb which is claimed from a man in the hour of national peril. But it has been less successful than the German in producing a reasoned conviction that daily sacrifice must be made by the individual for the welfare of the local community to which he belongs. And on the intellectual side British education, with brilliant exceptions, is, as compared with the German (tho not with the American), feeble, but markedly less so in Scotland than in other parts of the British Empire.

IV

The gravest defects of English education are: (1) The absence of an exacting standard in the training of the mind (as contrasted with training in conduct), with a resulting disparagement of the importance of general knowledge and a failure to realize the value of pure science as the fruitful source of new applications of scientific knowledge to the needs of life and industry; (2) uninstructedness of parental opinion in matters of education, showing itself in indifference to the quality of teaching and in capricious and casual choice of schools; (3) failure to stimulate the intellectual

interests of boys and girls of average capacity, with resulting wastefulness in the husbanding of the mental powers of the nation; (4) inertness of mind towards science, alike in industry, in public administration, and in domestic management; and (5) neglect in many homes and schools of proper pride in perfect cleanliness of the person, in grace of bearing and of manner, and in neatness of attire—a neglect which is accompanied by the serious evils of ignorance of the proper care of infant life, of uneconomical allocation of expenditure in the household budget, and of neglect of the remediable physical defects of children.

It is incumbent upon us to cure these defects for three reasons. First, the remediable defects in our English education are an obstacle to the growth of a fine social quality in our national life. They lessen the buoyancy, the adaptability, and, therefore, the happiness of the English people. Secondly, they gravely impair the future prospects of our industrial and commercial enterprise, and, by inducing want of foresight or neglect of desirable precautions and discipline, increase the cost of our administration. Thirdly, the weaknesses in our education will hamper us in fulfilling the great mission which has been entrusted to the British Empire, and to Great Britain more than any other part of the Empire, in upholding the principle of disciplined freedom and in maintaining the conviction that conscience and international morality, and not the absolute authority of the state, are sovereign in human affairs.

But we shall be called upon to find a remedy for these educational defects at a time of poverty, when, moreover, the hard question of the right education of girls and women will have become more than ever urgent, and when there will be many other anxious claims upon the thought of the nation—claims which will require us to deal with a variety of connected social problems at one and the same time and on a consistent plan. It is some consolation to know that there is evidence that, given the right discipline and training, the British are among nations one of the most respon-

sive to the influence of education. But great educational changes can not be lightly improvised or easily carried thru. And their full benefits (as Bacon said of planting woods and colonies) are not realized until after an interval of nearly 30 years. Nor can great educational improvements be enacted by administration or Parliamentary order alone. Education derives its power not from Acts of Parliament or administrative machinery, but from a spiritual movement of the national life. It needs organization and far-seeing direction, but it can easily be cramped by excess of administrative control. Confusion in educational standards is a bad thing, but over-organization a worse.

Our fundamental need in English education is for leadership by a great statesman, strong thru support from a great weight of public opinion and resolved to kindle in England a purposeful zeal for educational reform. Granted this, the national will would effectively focus itself on this question and produce such a change in our customary standpoint as to get far more than hitherto out of the devoted labors of our teachers and educational administrators. A world-famous thinker once said, "Whatever we wish to see introduced into the life of a nation must first be introduced thru its schools and universities." This is true, but the nation must be determined to get it thus introduced and must itself cooperate in diffusing its influence thru all the channels of home life and of industrial activity. And in order to further the British idea of civilization, British schools must essay a double task, endeavoring to impart both the love of knowledge and the care for conduct; love of adventure and readiness to endure routine; capacity for individual initiative and patience in the work of scientific cooperation.

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IX

DISCUSSIONS

THE BACCALAUREATE DEGREE AS AN OBSTACLE TO EDUCATIONAL PROGRESS

In the days of chivalry the page at the age of seven began a seven-year term of service, and then was bound to seven more years as squire before he was accepted into the fellowship of knights by the touch of a veteran; so the normal period of apprenticeship in the manual crafts was seven years. It would take us afield to trace even a little way the origin of this use of the number seven. But those were days when not all human institutions were under the control of pure reason. Have those days yet ended?

It was in those days that the baccalaureate originated. Whether the *baccalarius* was first a cow-herd, the tenant of a stock-farm, or something entirely else, it is certain that in the *universitas* or corporation—whether of smiths, tailors, or scholars—for some time before 1200 A.D. the term was practically a synonym of apprentice. Three stages in its history are pertinent to this inquiry: (1) the cause of its restricted use in the academic field; (2) its crystallization as a university degree; (3) its revival in America.

The baccalaureate under the faculty of arts in the University of Paris—which alone may be looked on as the ancestor of our own degree—was conferred in a student initiation ceremony in which the university officially had no part. The important features of it were (1) that it depended upon the time-unit as the measure of scholastic standing, (2) that it was preliminary to the study which was to follow. In respect to control the ceremony was more nearly akin to a cane-rush or sophomore cremation than to commencement day. There was reason for the measurement of proficiency by time in that knowledge then

was not acutely subdivided and consisted chiefly in acquaintance with certain books. The baccalaureate ceremony was part and parcel of the great wave for fraternization and organization that swept over Europe in the eleventh and twelfth centuries.

Within a hundred years the originally voluntary and half-playful ceremony had become a necessary preliminary to the ecclesiastical license to teach. And by 1400 A.D. at Paris, as elsewhere on the continent of Europe, it became synonymous with matriculation. At Oxford, however, it took a different turn, which is reflected in the early history of Harvard University and so of American colleges.

In the first statutes of Harvard the baccalaureate is referred to only as the first degree. It was given at the end of four years of residence, to be followed immediately by three more years leading to the master's, which was called the second degree. Note the total of years. There is no evidence of any intention or thought that any one would stop at this intermediate stage.

The development since then is obvious. As preparation has been more fully given before college entrance, the baccalaureate has been pushed up toward the end of the course; and the master's degree has crumbled away until it now represents the work of one supplementary year and recently was given without resident study after the baccalaureate; and but few bachelors proceed to it. The usurpation of the final place by the baccalaureate is justifiable provided the course which leads to it is modified to accord with the new position, so as to give it always a rational basis.

In this very brief sketch I have tried to give prominence to two thoughts: (1) that the time-unit is the traditional standard of measurement for the bachelor's degree; (2) that in its origin and still after transplantation to America it was a preliminary step to higher academic study. To these one other should be added: that the master's degree was always essentially a vocational degree and par excellence for one profession, teaching; in lesser degree as prerequisite to the study of theology and law. To what ex-

tent are these characteristics in accord with present educational thought and conditions?

May I assume that there are two conceptions of education, one as growth or general development, the other as specific preparation for specific ends; that the trend of modern educational thought is toward the latter, namely, that every element which enters into an educational course for an individual should work for a specific end in a specific way? That these ends may be vocational (concerned with the livelihood), avocational (pertaining to general human duties, such as citizenship, domestic life and social betterment), or liberal, directed solely to personal enjoyment? That every course should be centered around the vocational, with the addition of such avocational and, possibly, liberal material as is adapted to the temperament or capacity of the individual and can be included without unduly deferring vocational maturity?

There is now appparent a great contrast in present educational conditions: in comparison with the medieval university or with Harvard in the seventeenth century we have now an infinite differentiation of vocational ends to serve. It stands to reason that these vocations require various periods of time of preparation, from the elementary school plus zero years to seven, eight, or even more years after high school. The tradition of the baccalaureate has caused us to pad our college courses to fill time-units.

Is there any reason why a person who requires less vocational preparation should have a greater amount of avocational and liberal training, and vice versa, for the sake of making the totals equal? Should not the quantum of each of these, ideally, be adapted fully to the individual? Finally, is not any artificial stimulation to depart from the ideal, the antipode of useful?

The first effort to get away from the time-unit in this country probably was the elective system. But it was imperfect, because it still required a fixt number of unit-courses. The next effort was first made, I think, in this university (Columbia), the conferring of the baccalaureate

after one year of study in a professional school. This plan is manifestly applicable to a very limited number of vocations.

The question has become acute in the secondary field, and you see the secondary schools reaching down two years into the elementary and reaching up two years into college domain. Two-year and three-year commercial and other courses have been given for a long time. The secondary school is comparatively unhampered by graduation day,—shall I say, thanks to the fact that the baccalaureate got away from its original position?

Shall the baccalaureate be discarded? The whole question is involved with the doctrine of general training. Any action based upon faith in specific training for specific ends will be confounded by its opponents unless vocational value and avocational value are both interpreted in the very broadest manner, with accurate regard—so far as may be—to the ultimate effect of each study. For example, I should not hesitate to say that for many persons—other than teachers—Latin is at one stage the most vocational of all studies. Certainly no other study has in general greater avocational value than literature; yet for some its effect may be nil.

An alternative to summary execution is suggested by the plan of Columbia, and now of other universities. The degree might be given to those who have satisfied the college on the avocational side after they have practised efficiently for a certain time the vocation or profession to which they have been trained in the *alma mater*.

We have been accustomed to think of our college courses as standing like piles ready for laying the flooring of a pier. We should think of them rather as the pipes of a great church organ,—as many in number, perhaps, as there are individual students at any one time.

BARCLAY W. BRADLEY

NEW YORK CITY

MEN OR WOMEN TEACHERS—WHICH?

The absence of men teachers in the grammar public schools is undisputed. The need of them is quite generally conceded by those who stand for progress in education. How to secure them and retain them in the public school work is the problem which has not yet been satisfactorily solved.

Undoubtedly, an inadequate salary has much to do with the dearth of men teachers. The fact that the salary offered to the grammar school teacher is not sufficient to guarantee a living wage to a person who has a family dependent upon him, accounts, in large part, for the absence of strong men teachers there; it even eliminates many efficient women teachers. If they continue in the work at all, it is in the seconday schools or in the colleges where the salary is more nearly a living wage. And by a living wage is meant, to quote from Superintendent Maxwell, of New York, "a salary sufficient to enable the teacher to live in respectable society and to take advantage of reasonable means of culture and recreation."

When a salary of fifty, or sixty, or seventy-five dollars per month for nine or ten months of the year is offered to the well-equipt teacher, it disregards all thought of a living wage, it belittles the profession of teaching, it undertakes to degrade the teaching body, and, at most, it can only secure good teachers as a temporary makeshift, until a respectable livelihood can be secured in some other profession or work.

Men teachers, therefore, will never remain long in the teaching profession, unless the living wage, as defined by Superintendent Maxwell, is forthcoming. And they ought not to remain there. Every good citizen must approve of the unwillingness of a thoroly capable teacher continuing in a work that fails to assure a livelihood, progress and respectability.

The absence of permanency of employment is another consideration which operates to keep many good teachers out of the profession. School boards are known to play

politics and favoritism in the employment and the discharge of teachers. Even superintendents have been known to indulge in the most reprehensible methods affecting the permanency of employment of good teachers.

The desirability of some men teachers in the lower grades, as stated at the outset, is not a debatable question. It is universally conceded that no child is adequately educated who has not been in contact with the male, as well as the female, mind during some part of its school life. This has been recognized in Germany, where we find the men teachers doing important and valuable work in the schools. In that country there is no thought of dismissing them from the school service.

The commercial phase of public education has been so dominant in this country, that the best results have been impossible. And the educational atmosphere has also been contaminated with politics in the worst sense, as well as with favoritism, which is far worse and more dangerous. Nevertheless, there appears to be an awakening which gives promise of a fairer wage and the assurance of permanent employment when the work is well and efficiently performed.

The question of equal pay for equal work as between men and women teachers does not cut a very important figure in this discussion. Undoubtedly, while the demand for good men teachers is great and the supply small, the salary for them will be high, possibly higher than that of women teachers. And while the supply of good women teachers is great and the demand not so large, the salary, naturally, will not average so high, perhaps lower than that of men teachers. But the aim should always be to secure some teachers of both sexes in all grammar schools, the kindergarten and lower grades to be taught, preferably, by the women teachers, and the upper grades to be taught by the men teachers.

DUANE MOWRY

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X

REVIEWS

The teaching of history in elementary and secondary schools—By HENRY JOHNSON. New York: The Macmillan Company. 1915. xvii+497 p.

There is only one subject that is older than the subject of history, and that is education itself. As education is what all think worth doing, all feel themselves able to direct and not many feel it is worth studying or thinking about, so history is often what any one can study or teach or write without the trouble of serious professional training. The bibliographies that may be compiled on the subject of history teaching show that it has been under discussion for several centuries and yet the old theories divide, false ones flourish, practise and preparation lag behind precept and opportunity and what is advanced as new and a panacea proves to be the old, furbished up unconsciously for a new generation. No one should venture to add to the literature who is not modest, sensible, acquainted with past and present progress, foreign and native, who is not historically trained and in a position to give what has been proved in practise. It is high praise to say that the author combines these qualities in an eminent degree and that he has produced what is on the whole the best available work on the teaching of history in grade and secondary schools.

It is fortunate for historical teaching that Professor Johnson has prepared this manual, both because of its excellence and its timeliness. The position of history in the public school curriculum is just at present well worth the consideration of thoughtful students of education and of history. From the classical-mathematical training a sharp reaction brought in science and the teachers of the latter secure in the idea that it carried its own value on its face and that its proper method of presentation was so inherent and evidently neglected too often to think about method. The teachers

of science woke up to find that a quickly shifting age was demanding the social sciences and that even the classics by dint of revivifying teaching still cherished a ninth life. History came forward thru committees of ten and seven to claim four years in the high school. Then it dwindled and spoke in a less confident tone as committees of five and eight and various other numbers recognized that the stage was set to give vocational subjects the place before the footlights. Recent incomplete statistics in our middle western state seemed to show that 20 per cent of the high school students took ancient history, 10 per cent European history, 6 per cent American history and a negligible number English history. In the commercial high school of the largest city in that state, history had gone back to the old repudiated one year in general history from Adam to the present. In view of such a situation it is well that if poor teaching is any factor in this situation, it can measure its delinquencies by such excellent standards and improve by an application of the methods and ideals here outlined.

Professor Johnson's material is divided into sixteen chapters. In the earlier chapters he discusses what history is, its aims and values, its place in the European schools and at home, the problem of grading it for immature pupils, the merits and disadvantages of the biographical approach of the study of social groups and the imparting of a sense of reality. The later chapters are more concrete and no less practical in the best sense in their discussion of textbooks, maps, illustrative material, collateral reading, correlation and examinations. Chapter fourteen is a very sane plea for a reasonably early application of critical historical methods to history teaching in the grades and he has wisely given some very good illustrations. He holds no brief for the source method, does not expect to make embryo historians out of seventh grade pupils and is old-fashioned enough to believe that the pupil who does not remember the facts but thinks he knows their significance is a too-frequent and self-contented product of much of our teaching of history. Local and state history now much in demand is perhaps not sufficiently discust.

The problems of the grade teacher take precedence in many pages over those of the high school teacher. This is not necessarily an adverse criticism, and the grade teacher who is still subscribing for pedagogical periodicals showing new ways of cutting pie to illustrate functions will be bothered by the necessity of thinking for herself when Professor Johnson has done weighing the pros and cons of a theory or method. But it is what he wants her and her pupils to do. To say that the author is sometimes as unconclusive as a true historian ought to be is much higher praise even for a book on method than to say he is as positive as a pedagog is said to be.

Any teacher of history in the high school should have at hand four things: Professor Johnson's book, Andrews, Gambrill and Tall's *Bibliography*, Dr. Krey's little *Bulletin* and the files of the History Teachers' Magazine. If one adds the reports of the various committees of the American Historical Association, Professor Bourne's book and the publications of New England History Teachers' Association, one feels that the outlook for good history teaching in American schools is distinctly promising.

GUY STANTON FORD

UNIVERSITY OF MINNESOTA

A vigorous appeal to young men to prepare themselves for engineers as a profession and pointing out how best to follow it is contained in *Engineering as a career*, edited by Professor Newell, of the University of Illinois, and by Mr. C. E. Drayer, of the Cleveland Engineering Society. (New York: D. Van Nostrand Company, 1916. 214 p.)

Professor G. T. W. Patrick, of the University of Iowa, has written a stimulating volume which is at times quite in the Bergson manner, entitled *Psychology and relaxation*. (Boston: Houghton Mifflin Company, 1916. 280 p. $1.25.)

Interesting material, both for reading and for systematic study, will be found in *A short history of English rural life*, by Montagu Fordham, of Trinity College, Cambridge. The volume contains much which throws light on the political development of the English people. (New York: Charles Scribner's Sons, 1916. 184 p.)

XI

NOTES AND NEWS

Association of American Universities

The eighteenth annual conference of the Association of American Universities, held with Clark University, at Worcester, from November 9 to 11, 1916, was a return to earlier conditions. At some of the later meetings it has been altogether too apparent, to apply the figure of speech used under another academic situation, that what was originally intended to be a side-show had overshadowed the main performance. The conference of deans and similar officers of graduate schools, as the printed annoucements phrase it, has gradually deflected to itself, and doubtless largely by its more militant efforts to discuss and control the immediate details of administrative procedure that are vexing deans' minds, a large part of the live interest of these representatives of the universities who are naturally the usual delegates to the meetings of the Association, and left nothing but a secondary interest for that discussion of the wider and infinitely more important questions of actual education. The deans' conference, while it was again held, and held vigorously, at this meeting, did, nevertheless, leave for the general conference, altho evidently more by accident than design, some of its old functions, and the drying-out process that at one time seemed to threaten the life probability of the Association has been apparently averted, for there are still matters of vital moment in the always-expanding field of the higher education that call for careful thought and action.

The actual program of the Association as it was carried out was, first of all, the conference of deans, who this time discust the administration of fellowships and scholarships in the light of the interpretation that should be put on the provisions adopted by the Association at the annual meet-

ings of 1913 and 1914, which are contained in the Association's printed proceedings and which were reaffirmed. The report of a special committee on the classification of universities and colleges came in too late for final action and was laid over until the next meeting. In this same connection an interesting plan to secure the rating of colleges and universities on the thoro basis of the facts of educational organization and control was submitted and explained by Dr. Capen, of the U. S. Bureau of Education, whose cooperation in the matter had been asked by the Association. The plan was particularly approved by the Association as a means of securing the rating under reliable conditions of minor colleges in those states of the Union where there is no membership in the Association thru which otherwise such information is gathered. The question of granting graduate credit for work done in colleges having no organized graduate school and in absentia was considered at long length, but was not solved; as neither was the place and nature of the minor work for the Doctor's degree, i. e., the Ph.D. degree, where it was vigorously maintained by some of the deans and others that the minor subject had no nature and consequently no place in such work, at all.

The formal papers of the meeting at the first of the regular sessions were: How can Universities be so Organized as to Stimulate More Work for the Advancement of Science? by President Hall, of Clark University, and a further discussion of the same subject by Dean Woodbridge, of Columbia. President Hall's paper was largely made up of replies to a questionnaire sent out to the universities in the membership of the Association indicating their own attitude toward the question in its various phases. Dean Woodbridge made a plea in answer to the question of a more liberal recognition of the claims of research in the life of the university and for the provision of more and better facilities for research students.

At the second session President Hadley, of Yale, gave an admirable exposition of the whole subject of military

training in universities and colleges in its beginnings, its present conditions, and the place that ideally and really it should occupy in the future. It was conceived of by the speaker as a problem fundamentally of the undergraduate college and only incidentally of the graduate and professional schools. At the concluding session the report of a special committee under the chairmanship of Dean Leuschner, of the University of California, on academic and professional higher degrees was presented and discust, but was finally held over for further consideration and ultimate action. The two excellent papers of the session were on the correlation of work for higher degrees in the graduate school and in the professional schools, by Professors William H. Howell, of Johns Hopkins University, and Ernst Freund, of the University of Chicago.

Ohio State University was elected to membership in the Association.

Clark University was elected president for the ensuing year, with Indiana University as vice-president, and the University of Pennsylvania continued as secretary. The place of meeting of the next conference was left to the subsequent decision of the executive committee.

Scientific activity in Kansas

Three studies by the Bureau of Educational Measurements and Standards of the Kansas State Normal School, recently issued in pamphlet form, show the live interest of that institution in the constructive aspects of subjects taught intending teachers. They are, *The cost of instruction in Kansas high schools*, and *A report of the use of the Courtis standard research tests in arithmetic in twenty-four cities*, by Walter S. Monroe, professor of school administration and director of the Bureau, and *The Kansas silent reading test*, by F. J. Kelly, director of the training school.

The purpose of the investigation first mentioned was to determine what the cities of Kansas are paying for a unit of instruction in their high schools and what the important fac-

tors are in determining such cost. Information as to conditions of instruction upon which the report is based was secured from each high school teacher in 54 first and second class cities and 149 third class cities of the state. One student attending class for one period of forty-five minutes is taken as the unit of instruction. Such activities as coaching athletics, keeping study hall, and conference hours, were not considered, unless the program of a teacher showed clearly that as a consequence of this work she was given fewer teaching periods. No account was taken of the cost of classroom supervision or administration, since the study was purposely limited to the cost of instruction as primarily determined by the salary paid the teacher. The results are interesting as a record of what individual schools are directly paying for instruction in the separate subjects taught as a whole, but they scarcely go beyond this. Winfield, for instance, according to Table XXI, pays an average of $2.72 for all of the eleven subjects included in the statistics, while Baxter Springs pays $7.72 for seven. Elwood, in Table XXII, pays an average of $17.60 for six subjects and Effingham $3.00 for all.

The immediate factors which determine the cost of instruction from the point of view of the report are both the salary paid the teacher and the number of pupils she instructs. The tables, however, distinctly show that the actual salary of teachers is no reliable index of the price paid for instruction. Cities which pay the lowest salaries are not necessarily getting the cheapest instruction, and those cities which are paying the highest salaries are not inevitably the ones in which the instruction is the most expensive. A city in which the high school is so organized that a teacher instructs eighty to one hundred students each day may pay relatively high salaries and yet secure instruction at a relatively low price. In a school with a very small enrolment, on the other hand, the number of pupils in a class can not be large, and the relatively low salary paid the teacher may in the end indicate a higher price paid per unit for the instruction.

The tests in arithmetic were made in January and May, 1915, in grades four to eight in the schools of twenty-four Kansas cities. The so-called "Courtis tests" consist, in all, of four tests, one in each of the four fundamental operations with integers. The results are given in full in some sixty pages of tables. From them it appears that the standards set in the Courtis tests are not attained by 50 per cent of Kansas school children. The fact, however, that the standard for the number of examples attempted was equaled or exceeded in some cities shows that it is possible of attainment under the ordinary school conditions. On the other hand, continues the report, the fact that the standard of accuracy is attained only in a very few instances indicates that, in general, either more time must be given to the fundamental operations of arithmetic, or that more effective methods of teaching these operations must be devised. The conclusion is wisely arrived at that in the case of a pupil who is below the standard it will be an entirely safe procedure to prescribe special drills to remedy the defect. Pupils whose scores are distinctly above standard should be excused from further drill upon the operations and be allowed to spend their time more wisely in doing other things.

The reading test which is the subject of Professor Kelly's pamphlet was given to 9,252 children in the schools of nineteen Kansas cities. From the tables contained in the report it is apparent that the distribution of reading ability among the children of any given class is very wide. In nearly all the grades there are some children who can not do any of the exercises called for in five minutes. Assignments, further, which one-fourth of the children require five minutes or more to complete, may be done by another fourth of the class in two minutes or less in practically all grades. Allowing for the few cases where normal intelligence is lacking, concludes the report, the wide variation among the pupils who are supposed to do the same work in school, and, it is added, are promoted from grades, even tho they do not gain perceptibly in reading ability, indicates a serious problem confronting the teacher.

Carnegie Foundation Commission on insurance and annuities for college teachers

The Special Commission of Eleven to study and report to the trustees of the Carnegie Foundation upon the proposed plan to provide insurance and annuities for college and university teachers, the establishment of which was notified in the December issue of this REVIEW, has been constituted as follows:

From the Carnegie Foundation: President Henry S. Pritchett; President William F. Slocum, of Colorado College, Chairman of the Trustees; President William H. Crawford, of Allegheny College; Chancellor Samuel B. McCormick, of the University of Pittsburgh; Principal Sir William Peterson, of McGill University; President Charles R. Van Hise, of the University of Wisconsin.

From the Association of American Universities: President Frank J. Goodnow of Johns Hopkins University.

From the National Association of State Universities: President C. A. Duniway of the University of Wyoming.

From the American Association of University Professors: Dean Harlan F. Stone of Columbia University, and Professor H. L. Rietz of the University of Illinois.

From the Association of American Colleges: President Donald J. Cowling of Carleton College.

The Commission has already met and begun its task.

The new *Index* for Volumes 26–50 of the EDUCATIONAL REVIEW covering the years from June, 1903, to December, 1915, is now ready for distribution. Librarians and teachers who have ready access to this *Index* and to the earlier *Index* to Volumes 1–25, will find it possible to use quickly the entire fifty volumes of the EDUCATIONAL REVIEW with their contents of articles, discussions, book reviews and notes, covering every important educational topic and every important educational movement of the past quarter century. The possession and use of these two index volumes greatly increase the practical value of a full set of the EDUCATIONAL REVIEW.